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WORLD PETROLEUM OUTLOOK—1983

HEARING

BEFORE THE

COMMITTEE ON
ENERGY AND NATURAL RESOURCES
UNITED STATES SENATE

NINETY-EIGHTH CONGRESS

FIRST SESSION

TO REVIEW THE CURRENT STATE OF THE OIL MARKET AND TO EXPLORE THE VARIOUS FACTORS WHICH MAY AFFECT THE PRICE AND AVAILABILITY OF OIL IN THE NEAR FUTURE

FEBRUARY 21, 1983

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WORLD PETROLEUM OUTLOOK—1983

MONDAY, FEBRUARY 21, 1983

U.S. SENATE,
COMMITTEE ON ENERGY AND NATURAL RESOURCES,
Washington, D.C.

The committee met, pursuant to notice, at 10:05 a.m., in room SD-366, Dirksen Office Building, Hon. James A. McClure, chairman, presiding.

Present: Senators McClure, Warner, Johnston, Ford, and Melcher.

Also present: Howard Useem, professional staff member; Elizabeth Moler, counsel for the minority; Benjamin S. Cooper, professional staff member for the minority; and James T. Bruce, counsel for the minority.

Senator FORD [presiding]. The distinguished chairman asked that I proceed. He may be over listening to George Washington's farewell address. We shall proceed with the testimony of George Bradley, the Deputy Assistant Secretary for International Affairs in the Department of Energy, and if I am correct, you are accompanied by Dr. Dennis O'Brien and Dr. John Brodman.

You may proceed.

[The prepared statement of Senator McClure follows:]

OPENING STATEMENT OF HON. JAMES A. MCCLURE, A U.S. SENATOR FROM THE STATE OF IDAHO

The committee will come to order. This is the second day of oversight hearings on the world petroleum situation. Last Friday the committee received testimony in closed session from various agencies of the Federal Government. Today we will hear from the Department of Energy, the chief economist of the international energy agency, and from a panel of noted energy experts.

The purpose of this hearing is to review the current state of the oil market and to explore the various factors which may affect the price and availability of oil in the near future.

While we are all pleased with the recent decline in oil prices and we are hopeful that this trend will continue, we must bear in mind that the international oil market is not tranquil and that many of the factors which have led to the current oil "Glut" and price decline are transitory and may reverse with little warning. It would be be serious mistake to take the presence of an apparent glut of oil as proof that oil suppliers will always be plentiful at declining cost, and that it is therefore no longer necessary to be prepared for an oil supply interruption.

The unpredictability of the international energy situation has been amply demonstrated: over the past ten years there have been three major oil supply disruptions which have increased oil prices by more than ten fold. Over the past three decades there have been thirteen significant international oil supply interruptions, only three of which, I might note, occurred in countries outside the Middle East. Keep in mind that OPEC countries account for three quarters of the free world's proven oil reserves, while middle eastern members of OPEC account for three fifths of the world's oil reserves.

In late January the members of OPEC met in an attempt to stabilize the oil market, but their failure to reach an agreement has left the market in disarray. While this will surely result in lower oil prices during the near term, the longer term implications for oil prices and supply are less certain. For example, the lack of an agreement might lead to a major international price war which could, under certain circumstances, lead to the destabilization of certain producing countries and, as a result might lead to a sharp reduction in world oil supplies and an increase in prices. Recall that the Revolution in Iran resulted in the loss of nearly 4 million barrels per day of world oil supplies and a tripling of world oil prices.

But even if this particular scenario does not occur, there are other factors which are currently adversely affecting oil supplies. For example, Venezuela recently announced that it is scaling down its massive project to develop the Orinoco heavy oil field which is estimated to hold as much as two trillion barrels of heavy oil. Here in the United States, Exxon recently called off its $6 billion oil shale project in Colorado which would have produced as much as 50,000 barrels per day of oil. The U.S. rotary rig rate which hit a peak of 4,530 in December 1981, has since declined by nearly 50 percent to 2,335 at latest count.

Similarly, energy conservation activities which has been economic to undertake under higher prices are increasingly becoming less attractive. In that connection, I might note, the New York Times recently reported that as a result of falling gasoline prices, consumer tastes are beginning to shift away from small fuel efficient cars back to the larger and relatively less fuel efficient vehicles.

Before we abandon our efforts to assure ourselves an ample supply of oil both in normal times as well as for potential periods of supply interruption, and before we abandon our energy conservation and alternative fuels efforts, we must keep in mind that the current oil glut is not likely to persist indefinitely. Once economic recovery begins here and abroad, world wide demand for oil will return to its upward trend and the laws of supply and demand will once again dictate increasing prices for oil.

If we base our energy emergency preparedness policy on current levels of oil consumption and imports, and not on what we will be consuming and importing once our economic health is restored, we could well find ourselves back in the same highly vulnerably situation that we found ourselves during the 1973 oil embargo. In this regard, I want to express again my deep disappointment with this admininstration's shift in emphasis away from filling the strategic petroleum reserve as fast as possible. This decision is particularly tragic when we find ourselves in a period of low oil prices and the fill could be accomplished at less cost now than just a year ago.

I am confident that the hearing today will provide us with the latest analyses concerning the international oil situation and a better understanding of the forces which may affect it over the near term.

Our first witness is Mr. George Bradley, Deputy Assistant Secretary for International Affairs, Department of Energy.

STATEMENT OF HON. GEORGE BRADLEY, JR., PRINCIPAL DEPUTY ASSISTANT SECRETARY FOR INTERNATIONAL AFFAIRS, DEPARTMENT OF ENERGY, ACCOMPANIED BY DENNIS O'BRIEN, DEPARTMENT OF ENERGY; JOHN BRODMAN, DEPARTMENT OF ENERGY; AND ALBERT LINDEN, DEPUTY ADMINISTRATOR, ENERGY INFORMATION ADMINISTRATION, DEPARTMENT OF ENERGY

Mr. Bradley. Thank you, Mr. Chairman. Distinguished members of the committee, I welcome this opportunity to present the Department of Energy's views on the world oil situation and its——

Senator Ford. One of those microphones in there—it appears we are expecting Vice President Mondale here shortly—one of those would help you extend out into the audience, and I believe it is the one with the pink on it. Do you mind letting him have that one?

Mr. Bradley. It looks like I'm under attack.

Senator Ford. Let's see if that helps us some. Now proceed.

Mr. Bradley. I welcome this opportunity to present the Department of Energy's views on the world oil situation and its implications. Depending upon the level of detail you may wish to cover, I have in the room with me many of the DOE experts. If acceptable to the chairman, I will summarize the more lengthy statement which I have provided to be included in the record.

Senator FORD. Without objection.

Mr. BRADLEY. These hearings come at an interesting juncture in the oil market as producers and consumers alike remain poised for a possible decline in official oil prices. The possibility of a cut in nominal prices is greater now than it has been at any time in the recent past. This possibility derives from the continued softness in the world oil market which persisted throughout most of 1982 and is expected to continue well into 1983.

A number of factors are contributing to the weak oil markets and the resulting downward price pressures. They are the worldwide economic recovery projected to begin in the the fourth quarter of 1982 is not now expected to occur until after the latter half of 1983 and at a slower pace than previously anticipated.

Senator FORD. Would you repeat that one sentence?

Mr. BRADLEY. The worldwide economic recovery projected to begin in the fourth quarter of 1982 is not now expected to occur until the latter half of 1983 and at a slower pace than previously anticipated.

Unseasonably warm temperatures in the United States, Europe, and Japan have resulted in a large decline in winter oil demands.

Fuel switching and conservation, while diminished from the last few years, continue at a rate sufficient to further erode oil's share of total energy demands, and finally, surplus oil inventories persist in 1983 and are being liquidated at an apparently rapid rate in this quarter due to uncertainties over OPEC's future production and pricing levels.

OPEC's continuing inability to reach an agreement on a production rationing scheme is creating widespread expectations in the world oil market that a price reduction is imminent. In the immediate aftermath of the OPEC meeting oil companies, operating on the belief that a price cut was unavoidable, began to pull back, further refusing to lift any more crude oil than was absolutely necessary to cover customer demands.

In companies even among countries where production and exports have not yet fallen off as drastically, pressures for price cuts have mounted as oil companies have threatened to walk away to cheaper alternative supplies. In three cases or in several cases, the U.S.S.R., Egypt, and the United States, this has already produced a cut in prices of around $2 a barrel. In another case, the United Kingdom, Norway, the governments have just announced price cuts averaging $3 to $3.50 per barrel.

In addition, over the weekend the press has reported that Nigeria has announced a cut of around $5.50 a barrel. The threat of being viewed as a downward price leader, especially after Yamani's comments after the recent OPEC meeting, was probably the main reason they did not announce such a cut earlier. This climate has fueled speculation of an imminent price collapse to perhaps $20 or $25 per barrel.

We want to emphasize that the situation as we see it is ambiguous. While we have been careful to assess the impacts of such an eventuality, there is reason to believe that a cut in the Saudi benchmark crude of between $2 to $6 per barrel could occur.

I would like to briefly review our analysis of the outlook for world oil supply and demand through 1984, which is detailed in the tables accompanying my statement. I want to emphasize that projecting world oil prices has proven to be an "iffy" proposition in the past, and these projections are, of course, fraught with uncertainty. What we offer is an analysis of the variables relevant to any projection. We are not forecasting world oil prices.

The slide in world oil consumption which began in the aftermath of the Iranian revolution continued throughout 1982. The on-going effect of weak economic growth, price-induced conservation and substitution, and milder than normal temperatures resulted in a decline in world oil consumption of 1.6 million barrels a day, or about 3.8 percent in 1982.

The outlook for world oil consumption in 1983 remains uncertain and will depend on the timing and the pace of the economic recovery, the strength of the efficiency gains and fuel switching, oil price developments, and the relative strength of the dollar against other currencies.

The projected sluggish economic recovery in 1983 may limit growth in OECD primary energy demand to about 0.5 to 1 million barrels of oil equivalent. During this period, non-oil energy use is projected to increase about 1 million barrels or about 2 percent. Oil consumption as a result is projected to decline by about zero to 1 million barrels a day in 1983, depending on those factors previously mentioned. This decline is projected to occur in the United States, Western Europe, and Japan.

The pattern of yearly decline in oil consumption may reverse itself in 1984 with the onset of stronger economic growth and the dilution of the effects of past price increases.

Free world oil demand could increase by at least 2 percent next year under these circumstances, reaching about 45.9 million barrels a day or possibly more if there is a strong recovery in industrial output.

OECD oil consumption in 1984 could return to about the 1982 level of 34.4 million barrels a day. One possible projection of world oil production in 1983 would show minimal increase due to a significantly reduced rate of inventory liquidation. If not for the diminished rate of the drawdown of commercial inventories, world oil production would have been projected to fall once again. Instead, an increase of about 400,000 barrels a day or about 1 percent from 44.2 million barrels a day to 44.6 million barrels a day is projected for 1983. Increases of non-OPEC production of 600,000 barrels a day would more than accommodate this increase and offset the projected small decreases in OPEC production and net centrally planned economic exports.

At the same time, OPEC is projected to produce slightly less oil in 1983 than it did in 1982—18.7 million barrels of crude oil, an additional 1 million barrels of natural gas liquids. The exact distribution of production between the members of OPEC remains difficult to project. The production levels of individual OPEC members could vary substantially over the coming year, depending on changes in pricing policies.

In 1984, increasing consumption together with minor stock additions could raise demand for OPEC oil to 20 million barrels a day which is still 2½ million barrels a day lower than the 1981 level of 22.5 million barrels a day and 11.3 million barrels a day lower than the peak of 31.3 million barrels a day in 1977. Further production increases are possible in 1984 in the North Sea, Mexico, and the non-OPEC LDC's, while the U.S. production may remain largely unchanged from current levels.

Another factor which has been important in depressing oil production and exerting downward pressures on oil prices has been the pattern of oil inventory liquidation which occurred in 1982 and may continue in 1983. World oil inventory levels were estimated at 4.8 billion barrels at the end of 1982, nearly 500 million barrels more than at the end of 1981. Nevertheless, inventories at the end of 1982 remain high in terms of days of coverage. It is about 105 days forward consumption. This was primarily due to warmer than expected weather and increases in Government strategic stocks.

There is still, therefore, some margin for additional stock drawdowns in 1983. Moreover, some of the pressures behind stock liquidation remain—historically high but greatly reduced interest rates, low profits, weak product prices, low consumption, and unused production capacity, and above all at the present time, uncertainty over the future course of OPEC production and pricing policies.

For the rest of this decade, conditions in the world oil market will continue to be affected by ongoing structural adjustments to past oil and other energy price increases, and by the establishment of the major oil-producing countries in the Persian Gulf. While we cannot predict with certainty oil demand in the industrialized countries, it is projected to remain relatively flat, between 1983 and 1985, and to continue to decline slightly thereafter to 1990. This overall trend in the industrialized countries' oil demand, however, could be more than offset by rising oil demand within OPEC and non-OPEC developing countries.

In the absence of unexpected supply disruption, oil market conditions could remain favorable throughout the late 1960's. In spite of this relatively optimistic outlook, however, the overall oil market situation will continue to be affected by risk, uncertainty, and a continued threat of unexpected supply disruptions.

Thus we should not become complacent, but as this administration has done, continue to support measures to insure near-term energy security through the International Energy Agency and in the long term continue to seek paths toward building alternatives.

That concludes my statement, Mr. Chairman.

[The prepared statement of Mr. Bradley follows.]

TESTIMONY OF GEORGE BRADLEY
PRINCIPAL DEPUTY ASSISTANT SECRETARY FOR INTERNATIONAL AFFAIRS
DEPARTMENT OF ENERGY
BEFORE
THE SENATE COMMITTEE ON ENERGY AND NATURAL RESOURCES
FEBRUARY 21, 1983

MR CHAIRMAN AND DISTINGUISHED MEMBERS OF THE COMITTEE.

I WELCOME THIS OPPORTUNITY TO PRESENT THE DEPARTMENT OF ENERGY'S VIEWS ON THE WORLD OIL SITUATION AND ITS IMPLICATIONS.

THESE HEARINGS COME AT AN INTERESTING JUNCTURE IN THE OIL MARKET AS PRODUCERS AND CONSUMERS ALIKE REMAIN POISED FOR A POSSIBLE DECLINE IN OFFICIAL OIL PRICES. THE POSSIBILITY OF A CUT IN NOMINAL PRICES IS GREATER NOW THAN IT HAS BEEN AT ANY TIME IN THE RECENT PAST. THIS POSSIBILITY DERIVES FROM THE CONTINUED SOFTNESS IN THE WORLD OIL MARKET WHICH PERSISTED THROUGHOUT MOST OF 1982 AND IS PROJECTED TO CONTINUE WELL INTO 1983. A NUMBER OF FACTORS ARE CONTRIBUTING TO THE WEAK OIL MARKETS AND THE RESULTING DOWNWARD PRICE PRESSURE:

- THE WORLD WIDE ECONOMIC RECOVERY PROJECTED TO BEGIN IN THE FOURTH QUARTER OF 1982 IS NOT NOW EXPECTED TO OCCUR UNTIL THE LATTER HALF OF 1983 AND AT A SLOWER PACE THAN PREVIOUSLY ANTICIPATED:
- UNSEASONABLY WARM TEMPERATURES IN THE U.S., EUROPE AND JAPAN HAVE RESULTED IN LARGE DECLINES IN WINTER OIL DEMANDS;
- FUEL SWITCHING AND CONSERVATION CONTINUE AT A RATE SUFFICIENT TO FURTHER ERODE OIL'S SHARE OF TOTAL ENERGY DEMANDS; AND

- OIL INVENTORIES CONTINUE TO DECLINE IN 1983 AND ARE BEING LIQUIDATED IN THIS QUARTER DUE TO UNCERTAINTIES OVER OPEC'S FUTURE PRODUCTION AND PRICING LEVELS.

THE EFFECTS OF THE WEAK OIL MARKET AND SLACKENED ECONOMIC ACTIVITY ON OIL CONSUMPTION AND PRODUCTION TRENDS HAVE BEEN DRAMATIC:

- OPEC CRUDE OIL PRODUCTION FELL IN JANUARY 1983 TO AN ESTIMATED 17.5 MILLION BARRELS PER DAY (MMBD), THE LOWEST LEVEL SINCE 1967 AND NEARLY 13 MMBD BELOW 1977 PEAK PRODUCTION;
- OPEC'S SHARE OF FREE WORLD OIL SUPPLIES HAS FALLEN TO FORTY-FOUR PERCENT FROM 62 PERCENT IN 1977;
- SAUDI ARABIA HAS BORNE THE BULK OF THIS PRECIPITOUS DECLINE WITH ITS JANUARY CRUDE OIL PRODUCTION ESTIMATED AT 4.5 MMBD, COMPARED TO NEARLY 10 MMBD IN 1981;
- FREE WORLD OIL CONSUMPTION HAS DECLINED BY NEARLY 7.0 MMBD FROM ITS PEAK OF 52.4 MMBD IN 1979 TO 45.5 MMBD LAST YEAR;
- OIL CONSUMPTION REDUCTIONS IN THE U.S., WESTERN EUROPE AND JAPAN MORE THAN ACCOUNTED FOR THEIR DROP, OFFSETTING INCREASES IN OPEC AND OTHER LDC CONSUMPTION.
- THE SHARE OF NON-OPEC PRODUCTION IN FREE WORLD SUPPLY HAS INCREASED FROM 35 PERCENT TO 52 PERCENT BETWEEN 1973 AND 1982.

OPEC'S CONTINUING INABILITY TO REACH AN AGREEMENT ON A PRODUCTION RATIONING SCHEME IS CREATING WIDESPREAD EXPECTATIONS

IN THE WORLD OIL MARKET THAT A PRICE REDUCTION IS IMMINENT. SPOT PRICES FOR A BROAD RANGE OF CRUDE OILS ARE RUNNING \$5-\$6 BELOW OFFICIAL CONTRACT PRICES. THERE HAS ALSO BEEN A DECLINE IN OFFICIAL SALES PRICES (USP) OF CRUDE OIL TRADED INTERNATIONALLY TO AN ESTIMATED \$32.93 ON FEBRUARY 1 FROM \$33.05 ON OCTOBER 1, 1982, AND FROM \$35.53 DURING FEBRUARY 1981.

AT THE CURRENT TIME SAUDI ARABIA AND ITS ALLIES APPEAR TO HAVE ADOPTED A WAIT AND SEE ATTITUDE, PREFERRING TO OBSERVE THE EFFECT OF COMMERCIAL STOCK DRAWDOWN ON MARKET CONDITIONS AND TO SEE WHETHER MARKET REALITIES WILL EVENTUALLY FORCE OTHER OPEC MEMBERS TO ACCEPT SAUDI DEMANDS THAT THEY DISCONTINUE DISCOUNTING AND SHARE THE BURDEN OF SUPPORTING PRICES. MARKET REALITIES DO APPEAR TO BE TAKING THEIR TOLL ON OPEC AND NON-OPEC PRODUCERS ALIKE:

- NIGERIAN PRODUCTION IN FEBRUARY HAS REPORTEDLY FALLEN BELOW .8 MMBD FROM 1.3 MMBD LAST YEAR DUE TO THAT COUNTRY'S INABILITY TO COMPETE WITH CHEAPER NORTH SEA CRUDE; SOME COMPANIES HAVE COMPLETELY CURTAILED LIFTINGS FROM THIS COUNTRY;
- MEXICO, IN ORDER TO AVOID AN OBVIOUS PRICE REDUCTION, HAS ALLOWED CONTRACT BUYERS TO LIFT MORE OF ITS HEAVIER AND CHEAPER CRUDE;
- EGYPT HAS REDUCED PRICES FOR ITS CRUDE BY \$1-\$2 PER BARREL;
- U.S. PRODUCERS HAVE CUT THE PRICES OF DOMESTIC CRUDE BY \$1.00-\$2.00 PER BARREL.

THIS CLIMATE HAS FUELED SPECULATION OF AN IMMINENT PRICE COLLAPSE--TO PERHAPS $20 OR $25 PER BARREL. WE WANT TO EMPHASIZE THAT THE SITUATION AS WE SEE IT IS AMBIGUOUS. WHILE WE HAVE BEEN CAREFUL TO ASSESS THE IMPACTS OF SUCH AN EVENTUALITY, THERE IS REASON TO BELIEVE THAT A CUT IN THE SAUDI BENCHMARK CRUDE OF BETWEEN $2 AND $6 PER BARREL COULD OCCUR.

PRELIMINARY DOE ANALYSIS HAS CONCLUDED THAT EVEN A RELATIVELY PRECIPITOUS DECLINE IN OIL PRICES TO $20 A BARREL WOULD BE MANAGEABLE FROM AN ENERGY PERSPECTIVE. ADVERSE EFFECTS ON OIL INDUSTRY PROFITS AND ON ENERGY SECURITY FROM DIMINISHED INCENTIVES FOR EXPLORATION, CONSERVATION AND ALTERNATIVE ENERGY DEVELOPMENT COULD BE MORE THAN OFFSET BY INCREASED EFFICIENCY IN OTHER SECTORS, HIGHER REAL ECONOMIC GROWTH AND EMPLOYMENT, AND LOWER INFLATION. A DECLINE IN OIL PRICES IS GENERALLY A GOOD THING.

THE DEPARTMENT OF THE TREASURY HAS STUDIED THE BROADER INTERNATIONAL FINANCIAL IMPLICATIONS OF A POLITICAL OIL PRICE DECLINE AND WILL ADDRESS THE CONCLUSIONS IN THEIR TESTIMONY.

I WOULD LIKE TO BRIEFLY REVIEW OUR ANALYSIS OF THE OUTLOOK FOR WORLD OIL SUPPLY AND DEMAND THROUGH 1984 WHICH IS DETAILED IN THE TABLES ACCOMPANYING MY STATEMENT. I WANT TO EMPHASIZE THAT PROJECTING WORLD OIL PRICES HAS PROVEN TO BE AN "IFFY" PROPOSITION IN THE PAST, AND THESE PROJECTIONS ARE OF COURSE FRAUGHT WITH UNCERTAINTY. WHAT WE OFFER IS AN ANALYSIS OF THE VARIABLES RELEVANT TO ANY PROJECTION. WE ARE NOT FORECASTING WORLD OIL PRICES.

THE SLIDE IN WORLD OIL CONSUMPTION, WHICH BEGAN IN THE AFTERMATH OF THE IRANIAN REVOLUTION, CONTINUED THROUGHOUT 1982. THE ON-GOING EFFECTS OF WEAK ECONOMIC GROWTH, PRICE INDUCED CONSERVATION AND SUBSTITUTION, AND MILDER THAN NORMAL TEMPERATURES RESULTED IN A DECLINE IN WORLD OIL CONSUMPTION OF 1.8 MMBD, OR ABOUT 3.8 PERCENT, IN 1982.

THE DROP IN OECD OIL CONSUMPTION LAST YEAR OF 1.7 MMBD ACCOUNTED FOR VIRTUALLY ALL OF THE WORLD DECLINE AND BROUGHT OECD OIL DEMAND TO ITS LOWEST LEVEL IN 12 YEARS. THIS 4.7 PERCENT DECLINE IN OECD OIL DEMAND, WHEN COMPARED TO A GNP DECLINE OF ONLY ABOUT 0.5 PERCENT, ATTESTS TO THE CONTINUED STRENGTH OF EFFICIENCY GAINS AND FUEL SWITCHING IN VARIOUS OECD REGIONS:

- U.S. OIL DEMAND LAST YEAR FELL 6 PERCENT TO 15.2 MMBD LARGELY AS A RESULT OF DECLINES IN DEMAND FOR RESIDUAL AND DISTILLATE FUEL; THIS IS MORE THAN 3.5 MMBD BELOW THE 1978 PEAK.
- OIL DEMAND IN JAPAN AND IN WESTERN EUROPE BOTH FELL BY 4 PERCENT LAST YEAR, CONTINUING THE STEADY DECLINE BEGUN IN 1980.

THE OUTLOOK FOR WORLD OIL CONSUMPTION IN 1983 REMAINS UNCERTAIN AND WILL DEPEND ON THE TIMING AND PACE OF THE ECONOMIC RECOVERY, THE STRENGTH OF EFFICIENCY GAINS AND FUEL-SWITCHING, OIL PRICE DEVELOPMENTS AND THE RELATIVE STRENGTH OF THE DOLLAR AGAINST OTHER CURRENCIES.

THE PROJECTED SLUGGISH ECONOMIC RECOVERY IN 1983 (+1.5 PERCENT IN THE OECD REGION) MAY LIMIT GROWTH IN OECD PRIMARY ENERGY DEMAND TO ABOUT 0.5-1.0 MMBD OIL EQUIVALENT. DURING THIS PERIOD NON-OIL ENERGY USE IS PROJECTED TO INCREASE BY ABOUT 1.0 MMBD, OR ABOUT 2.0 PERCENT. OIL CONSUMPTION, AS A RESULT, IS PROJECTED TO DECLINE BY 0-1.0 MMBD IN 1983, DEPENDING ON THOSE FACTORS PREVIOUSLY MENTIONED. THIS DECLINE IS PROJECTED TO OCCUR IN THE UNITED STATES, WESTERN EUROPE, AND JAPAN: 1983 U.S. OIL CONSUMPTION COULD DECLINE TO 15.0 MMBD. THE LARGEST DECLINE IN WORLD CONSUMPTION IN 1983 COULD OCCUR IN THE FIRST QUARTER, WITH THE DECLINE BECOMING PROGRESSIVELY SMALLER IN THE SECOND AND THIRD QUARTERS. IN THE FOURTH QUARTER CONSUMPTION MAY ACTUALLY INCREASE FROM THE SAME PERIOD LAST YEAR, IF THE ASSUMPTIONS ABOUT ECONOMIC RECOVERY, CONSERVATION, GROWTH IN NON-OIL RESOURCES, AND THE WEATHER ARE ACCURATE.

THE PATTERN OF YEARLY DECLINES IN OIL CONSUMPTION MAY REVERSE ITSELF IN 1984, WITH THE ONSET OF STRONGER ECONOMIC GROWTH AND THE DILUTION OF THE EFFECTS OF PAST PRICE INCREASES. FREE WORLD OIL DEMAND COULD INCREASE BY AT LEAST 2 PERCENT NEXT YEAR UNDER THESE CIRCUMSTANCES, REACHING ABOUT 45.9 MMBD OR POSSIBLY MORE IF THERE IS A STRONG RECOVERY IN INDUSTRIAL OUTPUT. OECD OIL CONSUMPTION IN 1984 COULD RETURN TO ABOUT THE 1982 LEVEL OF 34.4 MMBD.

ONE POSSIBLE PROJECTION OF WORLD OIL PRODUCTION IN 1983 WOULD SHOW MINIMAL INCREASE DUE TO A SIGNIFICANTLY REDUCED RATE

OF INVENTORY LIQUIDATION. IF NOT FOR THE DIMINISHED RATE OF THE DRAWDOWN OF COMMERCIAL INVENTORIES, WORLD OIL PRODUCTION WOULD HAVE BEEN PROJECTED TO FALL ONCE AGAIN. INSTEAD, AN INCREASE OF ABOUT 0.4 MMBD, OR ABOUT ONE PERCENT, FROM 44.2 MMBD TO 44.6 MMBD IS PROJECTED FOR 1983. INCREASES IN NON-OPEC PRODUCTION OF 0.6 MMBD WOULD MORE THAN ACCOMMODATE THIS INCREASE AND OFFSET THE PROJECTED SMALL DECREASES IN OPEC PRODUCTION AND NET CPE EXPORTS. WHILE U.S. OIL PRODUCTION MAY REMAIN LARGELY UNCHANGED THIS YEAR AT ABOUT 10.7 MMBD, INCREASES ARE PROJECTED IN CANADA (+.1 MMBD); THE NORTH SEA (+.2 MMBD); MEXICO (+.2 MMBD); AND THE NON-OPEC LDCS (+.2 MMBD).

AT THE SAME TIME, OPEC IS PROJECTED TO PRODUCE SLIGHTLY LESS OIL IN 1983 THAN THEY DID IN 1982; 18.7 MMBD OF CRUDE OIL AND AN ADDITIONAL 1.0 MMBD OF NATURAL GAS LIQUIDS (NGL'S). THE EXACT DISTRIBUTION OF PRODUCTION BETWEEN THE MEMBERS OF OPEC REMAINS DIFFICULT TO PROJECT. THE PRODUCTION LEVELS OF INDIVIDUAL OPEC MEMBERS COULD VARY SUBSTANTIALLY OVER THE COMING YEAR DEPENDING ON CHANGES IN PRICING POLICIES. WITHOUT AN OPEC PRODUCTION AGREEMENT OR A CHANGE IN POLICY BY THE GULF PRODUCERS, IT IS POSSIBLE THAT SAUDI ARABIA AND ITS ALLIES MAY CONTINUE TO BEAR THE VOLUMETRIC BRUNT OF LOWERED OPEC PRODUCTION. AS A COROLLARY ONE COULD EXPECT VENEZUELA, LIBYA AND IRAN TO PRICE THEIR OIL IN SUCH A WAY AS TO MAINTAIN DESIRED PRODUCTION LEVELS.

OPEC'S FAILURE TO COME TO AN AGREEMENT ON A PRODUCTION PRORATIONING SCHEME AT THEIR JANAURY 23-24 MEETING AND THE CONSEQUENT EXPECTATIONS OF A PRICE CUT HAS LED COMPANIES TO CONTINUE TO REFRAIN FROM LIFTING CRUDE OIL, PREFERRING TO DRAW DOWN INVENTORIES ON THE ASSUMPTION THAT THEY CAN BE REPLACED AT A LOWER PRICE. THIS HAS HAD THE EFFECT OF FURTHER DEPRESSING OPEC PRODUCTION TO A JANUARY 1983 LEVEL ESTIMATED AT 17.5 MMBD. SHOULD THIS LEVEL BE MAINTAINED THROUGHOUT THE REMAINDER OF THE FIRST QUARTER, COMMERCIAL INVENTORIES MAY REACH A POINT EARLY IN THE SECOND QUARTER WHERE COMPANIES ARE UNABLE OR UNWILLING TO DRAW THEM DOWN FURTHER. AS A CONSEQUENCE, OPEC WOULD NOT EXPERIENCE THE BIG DROP-OFF IN PRODUCTION IN THE SECOND AND THIRD QUARTERS WHICH SOME ANALYSTS HAVE BEEN PREDICTING. NEVERTHELESS, EVEN THOUGH CONSUMPTION COULD REBOUND WITH THE ONSET OF ECONOMIC RECOVERY AND A RETURN TO MORE NORMAL SEASONAL TEMPERATURES, OPEC CRUDE OIL PRODUCTION IN THE FOURTH QUARTER OF 1983 IS PROJECTED TO REACH ONLY 20.5 MMBD. AS I HAVE EMPHASIZED, ALL OF THESE PROJECTIONS ARE TENTATIVE AND SUBJECT TO CHANGE, ESPECIALLY WHEN WE ARE TALKING ABOUT 1984.

IN 1984 INCREASING CONSUMPTION TOGETHER WITH MINOR STOCK ADDITIONS COULD RAISE DEMAND FOR OPEC CRUDE OIL TO ABOUT 20.0 MMBD, WHICH IS STILL 2.5 MMBD LOWER THAN THE 1981 LEVEL OF 22.5 MMBD, AND 11.3 MMBD LOWER THAN THE PEAK OF 31.3 MMBD IN 1977. FURTHER PRODUCTION INCREASES ARE POSSIBLE IN 1984 IN THE NORTH SEA, MEXICO, AND THE NON-OPEC LDCS (+.5 MMBD), WHILE U.S. PRODUCTION MAY REMAIN LARGELY UNCHANGED FROM CURRENT LEVELS.

ANOTHER FACTOR WHICH HAS BEEN IMPORTANT IN DEPRESSING OIL PRODUCTION AND EXERTING DOWNWARD PRESSURE ON OIL PRICES HAS BEEN THE PATTERN OF OIL INVENTORY LIQUIDATION WHICH OCCURRED IN 1982 AND MAY CONTINUE IN 1983.

WORLD INVENTORY LEVELS AT THE END OF 1982 WERE ESTIMATED AT 4,880 MILLION BARRELS, NEARLY 500 MILLION BARRELS LOWER THAN AT THE END OF 1981. NEVERTHELESS, INVENTORIES AT THE END OF 1982 REMAINED HIGH IN TERMS OF DAYS OF COVERAGE (105 DAYS OF FORWARD QUARTER CONSUMPTION) PRIMARILY DUE TO WARMER THAN EXPECTED WEATHER AND INCREASES IN GOVERNMENT STRATEGIC STOCKPILES. WHEN GOVERNMENT STRATEGIC RESERVES (ESTIMATED AT 650 MILLION BARRELS WORLDWIDE AT THE END OF 1982) ARE DEDUCTED FROM WORLD INVENTORY LEVELS, REMAINING COMMERCIAL INVENTORIES PROVIDE APPROXIMATELY 91 DAYS OF FORWARD COVER, COMPARED WITH 79 DAYS OF COVERAGE AT THE END OF 1978 AT THE OUTBREAK OF THE IRANIAN REVOLUTION.

THERE IS STILL, THEREFORE, SOME MARGIN FOR ADDITIONAL STOCK DRAWDOWNS IN 1983. MOREOVER, SOME OF THE PRESSURES BEHIND STOCK LIQUIDATION REMAIN: HISTORICALLY HIGH BUT GREATLY REDUCED INTEREST RATES, LOW PROFITS, WEAK PRODUCT PRICES, LOW CONSUMPTION, UNUSED PRODUCTION CAPACITY, AND ABOVE ALL AT THE PRESENT TIME, UNCERTAINTY OVER THE FUTURE COURSE OF OPEC PRODUCTION AND PRICING POLICIES. IN THE ATTACHED PROJECTIONS, OIL STOCKDRAW IS PROJECTED TO AVERAGE 0.4 MMBD IN 1983, BRINGING

INVENTORIES TO 4,750 MILLION BARRELS. INVENTORY MOVEMENTS ARE PROJECTED TO RETURN TO MORE TRADITIONAL SEASONAL PATTERNS IN 1984, AND TO INCREASE SOMEWHAT IN LINE WITH HIGHER COMSUMPTION.

FOR THE REST OF THIS DECADE, CONDITIONS IN THE WORLD OIL MARKET WILL CONTINUE TO BE EFFECTED BY ON-GOING STRUCTURAL ADJUSTMENTS TO PAST OIL AND OTHER ENERGY PRICE INCREASES, AND BY THE STABILITY OF THE MAJOR OIL-PRODUCING COUNTRIES IN THE PERSIAN GULF REGION. WHILE WE CANNOT PREDICT WITH CERTAINTY, OIL DEMAND IN THE INDUSTRIALIZED COUNTRIES IS PROJECTED TO REMAIN RELATIVELY FLAT BETWEEN 1983 AND 1985, AND TO DECLINE SLIGHTLY THEREAFTER TO 1990. THIS OVERALL TREND IN THE INDUSTRIALIZED COUNTRIES' OIL DEMAND, HOWEVER, COULD BE MORE THAN OFFSET BY RISING OIL DEMANDS WITHIN OPEC AND NON-OPEC DEVELOPING COUNTRIES.

UNDER THIS SCENARIO, DECLINING OIL PRODUCTION IN THE INDUSTRIALIZED COUNTRIES AND THE PROJECTED DECLINE IN THE CENTRALLY-PLANNED ECONOMIES NET OIL EXPORTS COULD LIMIT THE RATE OF INCREASE IN NON-OPEC SUPPLIES ESPECIALLY IN THE PERIOD AFTER 1985.

IN THE ABSENCE OF AN UNEXPECTED SUPPLY DISRUPTION, OIL MARKET CONDITIONS COULD REMAIN FAVORABLE THROUGH THE LATE 1980'S. IN SPITE OF THIS RELATIVELY OPTIMISTIC OUTLOOK, HOWEVER, THE OVERALL OIL MARKET SITUATION WILL CONTINUE TO BE EFFECTED BY RISK, UNCERTAINTY, AND THE CONTINUED THREAT OF UNEXPECTED SUPPLY DISRUPTIONS.

FREE WORLD OIL DEMAND
(Million barrels per day)

	1977	1978	1979	1980	1981	1982 1/	1983 2/	1984 2/
Consumption:								
United States 3/	18.4	18.8	18.5	17.1	16.1	15.2	15.0	15.3
U.S. Territories	0.4	0.4	0.4	0.4	0.3	0.4	0.4	0.4
Western Europe	14.0	14.4	14.8	13.5	12.5	12.0	11.7	11.9
Japan	5.4	5.5	5.5	5.0	4.7	4.5	4.4	4.4
Other IEA 4/	2.6	2.6	2.7	2.6	2.5	2.3	2.3	2.4
Subtotal IEA	38.2	39.0	39.1	35.8	33.8	32.2	31.9	32.4
Subtotal OECD	40.8	41.7	41.8	38.5	36.1	34.4	33.8	34.4
Other Developed Countries 5/	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.5
OPEC	2.1	2.3	2.5	2.7	2.8	2.9	3.0	3.1
Non-OPEC LDCs	6.6	7.1	7.5	7.7	7.8	7.6	7.6	7.7
Other 6/	.2	.2	.2	.2	.2	.2	.2	.2
Total	49.9	51.5	52.4	49.5	47.3	45.5	45.0	45.9
Inventory Change	+1.1	-0.5	+1.1	+0.8	-0.5	-1.3	-0.4	+0.3
Total Supply	51.0	51.0	53.5	50.3	46.8	44.2	44.6	46.2
Estimated End-of-Period Inventories (Million Barrels)	4,975	4,800	5,150	5,460	5,340	4,880	4,740	4,850

1/ Preliminary.
2/ Projected.
3/ Including processing gain.
4/ Canada, Australia, and New Zealand.
5/ Israel and South Africa.
6/ Military, losses, and unaccounted for demand.

Note: Details may not add to totals due to rounding.

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FREE WORLD OIL SUPPLY 1/
(Million barrels per day)

	1977	1978	1979	1980	1981	1982 2/	1983 3/	1984 3/
Non-OPEC								
United States 4/	10.4	10.8	10.7	10.8	10.7	10.8	10.7	10.6
Canada	1.6	1.6	1.8	1.8	1.6	1.5	1.6	1.6
North Sea	1.1	1.5	2.0	2.2	2.4	2.7	2.9	3.0
Other OECD 5/	0.8	0.8	0.8	0.8	0.9	0.9	0.9	0.9
Mexico	1.1	1.3	1.6	2.1	2.6	3.0	3.2	3.5
Other LDCs	3.1	3.3	3.5	3.6	3.8	4.0	4.2	4.3
Subtotal	18.1	19.3	20.4	21.3	22.0	22.9	23.5	23.9
OPEC								
Algeria	1.2	1.2	1.2	1.0	0.8	0.7		
Ecuador	0.2	0.2	0.2	0.2	0.2	0.2		
Gabon	0.2	0.2	0.2	0.2	0.2	0.1		
Indonesia	1.7	1.6	1.6	1.6	1.6	1.3		
Iran	5.7	5.2	3.2	1.7	1.3	2.3		
Iraq	2.3	2.6	3.5	2.5	1.0	1.0		
Kuwait	1.8	1.9	2.2	1.4	0.9	0.7		
Libya	2.1	2.0	2.1	1.8	1.1	1.2		
Neutral Zone	0.4	0.5	0.6	0.5	0.4	0.3		
Nigeria	2.1	1.9	2.3	2.1	1.4	1.3		
Qatar	0.4	0.5	0.5	0.5	0.4	0.4		
Saudi Arabia	9.0	8.1	9.2	9.6	9.6	6.3		
United Arab Emirates	2.0	1.8	1.8	1.7	1.5	1.3		
Venezuela	2.2	2.2	2.4	2.2	2.1	1.9		
Natural Gas Liquids	0.5	0.6	0.7	0.9	1.0	1.0		
Subtotal	31.8	30.5	31.7	27.8	23.5	19.8	19.7	21.0
Net Exports of Communist Countries	1.1	1.2	1.0	1.2	1.3	1.5	1.4	1.3
Total Supply	51.0	51.0	53.1	50.3	46.8	44.2	44.6	46.2

1/ Includes natural gas liquids.
2/ Preliminary.
3/ Projected.
4/ Including processing gain.
5/ Including Israel and South Africa.

Note: Details may not add to totals due to rounding.

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1981 FREE WORLD OIL DEMAND
(MMB/D)

	1980 Average	1981				1981 Average
		1st Q	2nd Q	3rd Q	4th Q	
Consumption						
United States 1/	17.1	17.1	15.6	15.5	16.0	16.1
U.S. Territories	0.4	0.4	0.3	0.3	0.3	0.3
Western Europe	13.5	13.8	11.6	11.3	13.2	12.5
Japan	5.0	5.5	4.2	4.2	4.8	4.7
Other IEA 2/	2.6	2.6	2.4	2.5	2.5	2.5
Subtotal IEA	35.8	36.8	32.1	32.0	34.3	33.8
Subtotal OECD	38.5	39.4	34.1	33.8	36.8	36.1
Other Developed Countries 3/	0.4	0.4	0.4	0.4	0.4	0.4
OPEC	2.7	2.8	2.8	2.7	2.8	2.8
Non-OPEC LDCs	7.7	7.7	7.8	7.8	7.7	7.8
Offshore Military and other	0.2	0.2	0.2	0.2	0.2	0.2
Total	49.5	50.5	45.3	44.9	47.9	47.3
Inventory Change	+0.8	-1.6	+2.5	+0.3	-2.5	-0.5
Total Supply	50.3	48.9	47.8	45.2	45.4	46.8
End of Period Inventory (million barrels)	5,460	5,315	5,545	5,570	5,340	5,340

1/ Including processing gain.
2/ Canada, Australia, and New Zealand.
3/ Israel and South Africa.

Note: Details may not add to totals due to rounding.

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1981 FREE WORLD OIL SUPPLY
(MMB/D)

	1980	1981				1981
	Average	1st Q	2nd Q	3rd Q	4th Q	Average
Non OPEC 1/						
United States 2/	10.8	10.7	10.6	10.6	10.8	10.7
Canada	1.8	1.7	1.6	1.6	1.6	1.6
North Sea	2.2	2.4	2.4	2.3	2.4	2.4
Other Developed Countries	0.8	0.9	0.9	0.9	0.9	0.9
Mexico	2.1	2.5	2.8	2.5	2.4	2.6
Other LDCs	3.6	3.7	3.8	3.8	3.7	3.8
Subtotal	21.3	21.9	22.1	21.7	21.8	22.0
OPEC						
Algeria	1.0	1.0	0.9	0.8	0.7	0.8
Ecuador	0.2	0.2	0.2	0.2	0.2	0.2
Gabon	0.2	0.1	0.1	0.2	0.2	0.2
Indonesia	1.6	1.6	1.6	1.6	1.6	1.6
Iran	1.7	1.5	1.5	1.2	1.1	1.3
Iraq	2.5	0.8	1.0	1.1	1.1	1.0
Kuwait	1.4	1.4	0.9	0.8	0.8	0.9
Libya	1.8	1.6	1.4	0.7	0.9	1.1
Neutral Zone	0.5	0.5	0.3	0.3	0.3	0.4
Nigeria	2.1	1.9	1.4	0.8	1.6	1.4
Qatar	0.5	0.5	0.4	0.3	0.3	0.4
Saudi Arabia	9.6	9.9	10.0	9.7	8.8	9.6
United Arab Emirates	1.7	1.6	1.5	1.5	1.4	1.5
Venezuela	2.2	2.2	2.1	1.9	2.2	2.1
NGLs	0.9	0.9	1.0	1.1	1.1	1.0
Subtotal	27.8	25.7	24.4	22.2	22.3	23.5
Net CPE Exports	1.2	1.3	1.3	1.3	1.3	1.3
Total Supply	50.3	48.9	47.8	45.2	45.4	46.8

1/ Including natural gas liquids (NGLs).
2/ Including processing gain.

Note: Details may not add to totals due to rounding.

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1982 FREE WORLD OIL DEMAND
(MMB/D)

	1981 Average	1982				1982 Average
Consumption		1st Q	2nd Q	3rd Q	4th Q	
United States 1/	16.1	15.8	15.2	14.8	14.9	15.2
U.S. Territories	0.3	0.4	0.4	0.4	0.4	0.4
Western Europe	12.5	13.4	11.6	11.1	12.0	12.0
Japan	4.7	5.3	4.0	4.1	4.5	4.5
Other IEA 2/	2.5	2.5	2.3	2.3	2.3	2.3
Subtotal IEA	33.8	34.7	31.3	30.9	32.0	32.2
Subtotal OECD	36.1	37.4	33.5	32.7	34.1	34.4
Other Developed Countries 3/	0.4	0.4	0.4	0.4	0.4	0.4
OPEC	2.8	2.9	2.9	2.9	2.9	2.9
Non-OPEC LDC's	7.8	7.6	7.6	7.6	7.6	7.6
Offshore Military and Other	0.2	0.2	0.2	0.1	0.2	0.2
Total	47.3	48.5	44.6	43.7	45.2	45.5
Inventory Change	-0.5	-3.8	-1.6	+0.3	0.0	-1.3
Total Supply	46.8	44.7	43.0	44.0	45.2	44.2
End of Period Inventory (million barrels)	5,340	5,000	4,855	4,880	4,880	4,880

1/ Including processing gain.
2/ Canada, Australia, and New Zealand.
3/ Israel and South Africa.

Note: Details may not add to totals due to rounding.

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1982 FREE WORLD OIL SUPPLY
(MMB/D)

	1981 Average	1982 1st Q	1982 2nd Q	1982 3rd Q	1982 4th Q	1982 Average
Non OPEC 1/						
United States 2/	10.7	10.8	10.8	10.8	10.7	10.8
Canada	1.6	1.5	1.5	1.6	1.6	1.5
North Sea	2.4	2.5	2.7	2.7	2.8	2.7
Other Developed Countries	0.9	0.9	0.9	0.9	0.9	0.9
Mexico	2.6	2.7	3.0	3.0	3.2	3.0
Other LDCs	3.8	3.9	4.0	4.1	4.1	4.0
Subtotal	22.0	22.3	22.9	23.1	23.3	22.9
OPEC						
Algeria	0.8	0.7	0.6	0.7	0.7	0.7
Ecuador	0.2	0.2	0.2	0.2	0.2	0.2
Gabon	0.2	0.1	0.1	0.1	0.1	0.1
Indonesia	1.6	1.5	1.3	1.3	1.3	1.3
Iran	1.3	1.4	2.3	2.5	2.9	2.3
Iraq	1.0	1.5	0.8	0.8	0.8	1.0
Kuwait	0.9	0.7	0.6	0.7	0.7	0.7
Libya	1.1	0.8	0.8	1.4	1.7	1.2
Neutral Zone	0.4	0.3	0.3	0.3	0.3	0.3
Nigeria	1.4	1.4	1.3	1.2	1.4	1.3
Qatar	0.4	0.4	0.3	0.3	0.4	0.4
Saudi Arabia	9.6	7.9	6.3	5.8	5.4	6.3
United Arab Emirates	1.5	1.4	1.2	1.2	1.3	1.3
Venezuela	2.1	1.9	1.5	1.9	2.2	1.9
NGLs	1.0	1.0	1.0	1.0	1.0	1.0
Subtotal	23.5	20.9	18.6	19.4	20.4	19.8
Net CPE Exports	1.3	1.5	1.5	1.5	1.5	1.5
Total Supply	46.8	44.7	43.0	44.0	45.2	44.2

1/ Including natural gas liquids (NGLs).
2/ Including processing gain.

Note: Details may not add to totals due to rounding.

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1983 FREE WORLD OIL DEMAND OUTLOOK
(MMB/D)

	1982 Average	1983 1st Q	1983 2nd Q	1983 3rd Q	1983 4th Q	1983 Average
Consumption						
United States 1/	15.2	15.1	14.7	14.6	15.5	15.0
U.S. Territories	0.4	0.4	0.4	0.4	0.4	0.4
Western Europe	12.0	12.6	11.2	11.0	12.2	11.7
Japan	4.5	5.1	3.9	4.0	4.5	4.4
Other IEA 2/	2.3	2.3	2.2	2.3	2.4	2.3
Subtotal IEA	32.2	33.7	30.2	30.5	33.2	31.9
Subtotal OECD	34.4	35.5	32.4	32.3	35.0	33.8
Other Developed Countries 3/	0.4	0.4	0.4	0.4	0.4	0.4
OPEC	2.9	2.9	3.0	3.0	3.1	3.0
Non-OPEC LDC's	7.6	7.5	7.6	7.6	7.6	7.6
Offshore Military and Other	0.2	0.2	0.2	0.2	0.2	0.2
Total	45.5	46.5	43.6	43.5	46.3	45.0
Inventory Change	-1.3	-3.0	+0.1	+1.0	+0.3	-0.4
Total Supply	44.2	43.5	43.7	44.5	46.6	44.6
End of Period Inventory (million barrels)	4,880	4,610	4,620	4,710	4,740	4,740

1/ Including processing gain.
2/ Canada, Australia, and New Zealand.
3/ Israel and South Africa.

Note: Details may not add to totals due to rounding.

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1983 FREE WORLD OIL SUPPLY PROJECTION
(MMB/D)

	1982	1983				1983
	Average	1st Q	2nd Q	3rd Q	4th Q	Average
Non OPEC 1/						
United States 2/	10.8	10.8	10.7	10.7	10.6	10.7
Canada	1.5	1.6	1.6	1.6	1.6	1.6
North Sea	2.7	2.8	2.9	2.9	2.9	2.9
Other Developed Countries	0.9	0.9	0.9	0.9	0.9	0.9
Mexico	3.0	3.1	3.2	3.3	3.3	3.2
Other LDCs	4.0	4.1	4.1	4.2	4.3	4.2
Subtotal	22.9	23.3	23.4	23.5	23.6	23.5
OPEC						
Algeria	0.7					
Ecuador	0.2					
Gabon	0.1					
Indonesia	1.3					
Iran	2.3					
Iraq	1.0					
Kuwait	0.7					
Libya	1.2					
Neutral Zone	0.3					
Nigeria	1.3					
Qatar	0.4					
Saudi Arabia	6.3					
United Arab Emirates	1.3					
Venezuela	1.9					
NGLs	1.0					
Subtotal	19.8	18.7	18.9	19.7	21.6	19.7
Net CPE Exports	1.5	1.5	1.4	1.4	1.4	1.4
Total Supply	44.2	43.5	43.7	44.6	46.6	44.6

1/ Including natural gas liquids (NGLs).
2/ Including processing gain.

Note: Details may not add to totals due to rounding.

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Senator JOHNSTON. Thank you, Mr. Bradley. Mr. Bradley, there is a chart called "Free World Oil Demand" in the back of your testimony which shows a free world oil demand of 45 million barrels per day in 1983.

Does that include natural gas liquids?

Mr. BRADLEY. Yes, it does, Mr. Senator.

Senator JOHNSTON. And does that include imports from the Communist countries? I think they are about 1 million barrels a day.

Mr. BRADLEY. Yes.

Senator JOHNSTON. That includes everything, that 45 million barrels a day?

Mr. BRADLEY. Yes.

Senator JOHNSTON. Now on free world oil supply you show—could you help me with this chart? It says free world oil supplies. You have non-OPEC and OPEC with a total supply in 1982 of 44.6. Am I correct on that?

Mr. BRADLEY. Yes, sir.

Senator JOHNSTON. So you show an actual shortage of oil in 1983? Do I read that correctly?

Mr. BRADLEY. No. The difference is met by stock drawdown.

Senator JOHNSTON. By what?

Mr. BRADLEY. Stock draw, drawdown in stocks; if you look on the demand table, you will see minus 0.4. That is 400,000 barrels a day stock draw that we are projecting. If you add the 400,000 barrels a day stock draw to the 44.6, then you have 44.

Senator JOHNSTON. Well, now this total supply, that doesn't mean capacity.

Mr. BRADLEY. No—total.

Senator JOHNSTON. That just means production?

Mr. BRADLEY. That just means production at that point, yes, sir.

Senator JOHNSTON. Now do you have the chart in here that says capacity?

Mr. BRADLEY. No, we do not.

Senator JOHNSTON. Now would you run through those figures of free world oil capacity again, measured the same as your free world oil demand?

Mr. BRADLEY. You want me to run through the capacities?

Senator JOHNSTON. Yes.

Mr. BRADLEY. The capacity as of the current moment, as you might recall, we are estimating that the capacity would be about an additional 10 million barrels a day, so if you add the 10 million barrels a day to the 45 million barrels a day, then we estimate it is about 55 million barrels a day of maximum sustainable capacity.

Senator JOHNSTON. All right. How long would you say that that 10 million barrels a day surplus of capacity will last given whatever assumptions you would like to make?

Mr. BRADLEY. Well, I mean first of all, I think that, at least I am not, I can't predict the future. On the other hand, while I know I can't predict the future, let me just say that approximately 7 million barrels of that 10 million barrels is in one region of the world, and that region of the world is very volatile, being in the Middle East, so you know, I would sort of leave it to——

Senator JOHNSTON. I understand all of those assumptions. Your primary assumption is demand. You also look at oil in the ground and oil wells drilled. Those are the primary assumptions; given those primary assumptions, is there any reason to think that that surplus, that 10-million-barrel-a-day surplus, over the next 5 years or 10 years should be any less?

Mr. BRADLEY. Yes, there is reason to believe it would be less. Let's say in the current environment that we are in where we are projecting in facts and the spot market prices have already declined and we are saying that the prospects are greater now for a decrease in nominal prices, and even if that is only on the order of two to six, then with economic recovery plus the price decrease, we would certainly expect an increase in demand so that we would—but I wouldn't expect a surge in demand to the extent that you would see that, the excess capacity, surplus capacity, disappear overnight. We are looking into probably toward the end of the eighties into the nineties if that capacity would disappear.

Senator JOHNSTON. All right, so you would say we are going to have a surplus of oil through the late eighties or into the nineties in your judgment?

Mr. BRADLEY. Yes.

Senator JOHNSTON. With most assumptions?

Mr. BRADLEY. Recognizing that no one can predict the future, but yes.

Senator JOHNSTON. You say in your statement there is speculation of an imminent price collapse to perhaps $29 or $25 per barrel. That would seem to say to me that there is a very excellent chance that would happen because of the long-term surplus. It is going to be around for a long, long time. Wouldn't that be correct?

Mr. BRADLEY. Partly.

Senator FORD. Mr. Bradley, I am trying to recall an article I read in the last week or 10 days which reflected as I recall the Canadian Government. Basically this article said that Canada was allowing their producers to make the best kind of arrangements with the American consumer today, likewise users and others, as they could because they were projecting a shortage for us in natural gas in 1986.

Now you in your documentation here included natural gas in your total where you cannot predict the future. You say it is unpredictable. Apparently our neighbor to the north has made an assumption anyhow as to our shortage.

Do you have a comment to make about that?

Mr. BRADLEY. Maybe they are projecting that we will still have decontrol, Senator.

Senator FORD. I can't hear you.

Mr. BRADLEY. Maybe they are projecting that we will still have controls. Of course, we are hoping that we will not. I would think that given an effort to lift controls, we guess gas would be more plentiful.

Senator FORD. Are you proposing that we decontrol the low-cost gas?

Mr. BRADLEY. Well, our analysis of the market would indicate that it is not low but high.

Senator FORD. I am talking about low-cost gas that is folded into the high-cost gas, reducing the cost to the consumer on an average.

Mr. **Bradley**. But the recent events would indicate that that situation has turned around so that you are really not able to roll in high-cost gas with low-cost gas. Quite a few of the markets, given the way that the long-term contracts are set, they are locked in at high prices such as the 107 deep gas, some of the Canadian gas, and these sorts of things which are resulting in higher prices in the marketplace than would otherwise be allowed if those long-term contracts did not exist. The long-term contracts are locking in buyers at a higher price than the current market would provide.

Senator **Ford**. Aren't most of the pipelines, consumers, distribution systems, renegotiating the so-called take and pay? Aren't they moving that down from some 90 percent, moved down to 50 percent and with a maximum of 70? Aren't we seeing that now?

Mr. **Bradley**. No, Senator, information DOE has indicates some but not most interstate pipelines have been able to renegotiate contracts to lower the take-or-pay requirement. We also have information that many pipelines have exercised so-called market-out clauses in their contracts. These allow pipelines to reduce the price they pay for gas, generally high-cost NEPA 107 gas, under conditions specified in the contract—each of which is different. Our data indicates some pipelines have marketed-out from $7 gas down to $4 or $5 gas and, in a few instances, to the $3.50 level.

Senator **Ford**. Well, I am leading up to something my colleague to the right knows more about or as much about as anyone on this committee, but it does indicate to me that—is it 104 gas that is old gas? And if you decontrol that, then you allow that to seek its level, that you automatically immediately increase the cost to the consumer.

Mr. **Bradley**. I don't necessarily agree with that because let's assume that we have a situation whereby that we are in now where we are projecting a price decline in oil, and one of the things that one needs to be aware of is that if we have a price decline in oil and if then oil, especially in the industrial sector where a large part, where a large part of that sector has dual-fired capacity, can switch fuel, that you might end up with a significant increase in demand and backing out a lot of gas if you have regulated gas.

On the other hand, if you deregulate the gas and the gas prices will decline and follow oil prices and possibly even go lower——

Senator **Ford**. Why should we tie natural gas to oil? Why can't we let it sit on its own bottom?

Mr. **Bradley**. Well, if you are asking——

Senator **Ford**. Why don't you tie us to coal?

Mr. **Bradley**. I think if it was me, you know, and I was sitting there, I would want to tie it to all the other energy sources because one of the things that we want to be concerned about I would think, especially as we try to plan for the future and prepare for near-term as well as long-term emergency situations, is to have all the fuel available that we might have so that it can possibly substitute in the event we would have a loss of the excess capacity in our existing oil.

Senator **Ford**. Explain to me why you have cut in the Department of Energy by two-thirds research and development for new sources of energy.

Mr. Bradley. That is not accurate, Senator, because as you know quite well, our request for this year in 1983 is significantly higher than the administration's——

Senator Ford. For what?

Mr. Bradley. The administration's request last year.

Senator Ford. But we put in 300 million. You requested 118 million last time. This time you are requesting 136 billion. That may be significantly higher than you requested last time and it is your use of words. The Congress put in over 300 million. Now if it is significantly higher than you requested last time, why is it significantly lower than what the Congress put in the budget that the President signed?

Mr. Bradley. I certainly wouldn't want to stand in the way of the desires of Congress, Senator.

Senator Ford. You just said you increased. You didn't. You reduced it by 200 million.

Mr. Bradley. Yes, sir, but there is another point to this I think, and the point is that, the fact that the budget now shows trends that takes into account the concerns of Congress, and as the Secretary said, I think rightfully so, because he wants to project a path that would hopefully lead to an accelerated development of a number of these alternative fuels, but I think more importantly, it is a question of not attempting to solve problems by pouring money down an open pit. That is not the only way to deal with a problem, and I think that as the Secretary has said, I think that the question here is one of leadership, as the chairman of this committee has demonstrated over the years, and the collective leadership of the country trying to develop a consensus on where we are going in energy, and certainly that is more important than pouring money into particular technologies.

Senator Ford. Well, you know, we are talking about energy. Other countries figure we are going to be short and you keep making it shorter.

Let me ask you what effect would a price cut have on our domestic banks, in oil?

Mr. Bradley. Well, that is a question for the Department of Treasury. We don't really perform analysis on that.

Senator Ford. You haven't done any kind of a survey on the effect to our domestic banks by a cut in the price of oil?

Mr. Bradley. I think the Treasury Department has performed some analysis.

Senator Ford. Have they given you that information?

Mr. Bradley. They have talked to, we have participated in an interagency study that has looked at all aspects of this, yes, sir.

Senator Ford. The interagency task force that you are on, what did that relay as it relates to domestic banks and the problems that they might run into as regards the reduction of oil prices?

Mr. Bradley. Well, I didn't participate in the actual, I personally did not participate in the task force that dealt with the domestic financial element of the study.

Senator Ford. Did anybody report to you on what the presumption might be?

Mr. Bradley. Well, yes. To answer the question, the bottom line was, is that——

Senator FORD. Many of them are in trouble, aren't they?

Mr. BRADLEY. No—that the reduction on the order of the two to six would have no impact and the larger reduction could be dealt with.

Senator FORD. Well, let me ask you this then. We will talk about international. Just two more questions, Mr. Chairman, and I will be through.

As the price of oil drops, there are fears about the financial and political future of Mexico as well as the future of the world banking system.

Could we buy more oil for SPRO from Mexico, and if we can, how much more and when?

Mr. BRADLEY. I am informed that we are buying Mexican oil at the rate of about 150,000 barrels a day this year, about 50,000 barrels a day next year. We will make further decisions at the appropriate time.

Senator FORD. Isn't there a minimum number of barrels to be purchased daily on an average by law?

Mr. BRADLEY. Are you saying with respect to the SPR?

Senator FORD. Yes.

Mr. BRADLEY. Is that the question? Well, it is my understanding that the legislation calls for a minimum in fiscal year 1983 of 220,000 barrels per day.

Senator FORD. That is correct, and you are averaging about 145 and this is an opportunity at the right price to fill SPRO.

Mr. BRADLEY. That is not correct. We are averaging 220,000 barrels per day in fiscal year 1983.

Senator FORD. No, you are not. Our totals show fiscal year 1984, that your proposal——

Mr. BRADLEY. Eighty-four?

Senator FORD. You are not going at 220 this year, are you?

Mr. BRADLEY. Yes. We are filling at the rate of 220,000 barrels per day.

Senator FORD. You are something short of 220. You are around 215, but yet you are proposing to reduce that to 145. Am I correct in that?

Mr. BRADLEY. I understand the fiscal year 1984 budget proposal is to fill at 145,000 barrels per day during fiscal year 1984, yes, sir.

Senator FORD. Ok. Let me ask you one final question. Then what has the administration done to encourage OPEC to lower its prices?

Mr. BRADLEY. If I might, Senator, I would like to say something. You know, on the SPRO fill, the 145,000 barrels per day in fiscal year 1984, the question that I would ask myself, I would say would I buy a TV today if I knew the price was going to be lower tomorrow? But that is my view of the world. I think that you need to consider the price factor.

Senator FORD. On that basis you would never buy an insurance policy?

Now what has the administration done to encourage OPEC to lower its prices?

Mr. BRADLEY. We in the Department of Energy have taken no direct action with respect to OPEC. We continue to work, we continue to work to remove impediments from the marketplace and to work with our allies and friends to deal with the near-term as well as the long-term problem, and this in and of itself I think is a driving force to lower world oil prices.

Senator **Ford**. Thank you, Mr. Chairman.

The **Chairman** [Senator McClure presiding]. Thank you. Senator Melcher?

Senator **Melcher**. Thank you, Mr. Chairman. Mr. Bradley, what would you project the shift in consumption to be if various oil prices drop to around $20 to $25 per barrel?

Mr. **Bradley**. You want me to predict if that would occur?

Senator **Melcher**. Pardon me?

Mr. **Bradley**. What is the question?

Senator **Melcher**. What would you project to be the shift in oil consumption?

Mr. **Bradley**. If the oil dropped to——

Senator **Melcher**. Twenty to twenty-five dollars per barrel, here in the United States; what would be the shift in the consumption here?

Mr. **Bradley**. It is conjecture. First of all, I just want to preface it by saying it is almost impossible to predict, but on the other hand, I think that the experts feel that demand would rise something on the order of 1 million barrels a day by 1985.

Senator **Melcher**. What would be the projected shift in consumption of oil for home heating?

Mr. **Bradley**. I would say that, first of all, it depends on what happens to natural gas prices. I think one element, another element in the equation would be the investment in capital equipment and the fact of the timing of the turnover in that capital equipment, and you are talking about a 10- or 15-year period. There are a number of variables in that equation.

Senator **Melcher**. Do you have any projections for the increase in consumption of oil for industrial purposes in the United States if that price should develop, $20 to $25 per barrel?

Mr. **Bradley**. Well, the industrial sector at least in my view is the easiest one because, as I said, I think our most recent studies, some studies I have seen say about 40 percent of that sector has fuel switching capability, and one would project that, and I think they are utilizing on the order of 1 million barrels, million barrels a day in that particular sector, and the outlook would say that they would probably switch to cheaper, you know, they would switch from other fuels to utilize oil if oil is a cheaper fuel.

Senator **Melcher**. Well, what are your projections? Would that million shift to 1½ million, 1.7 million 7, 2 million?

Mr. **Bradley**. By when?

Senator **Melcher**. Well, I will let you choose any year you want, but let's say 1984, 1985, 1986.

Mr. **Bradley**. Again, I would say that given the fact that we have—we don't have an exact figure on that.

Senator **Melcher**. I know you don't have an exact figure, but I am just asking if you have a projected figure?

Mr. **Bradley**. Yes. What we would feel is that the economy would benefit from that. I mean employment would go up. Industry would gain higher profits. Output would increase so that the overall benefits would be great to the economy.

Senator **Melcher**. You have a projection that possibly, let's say for 1985, consumption in the United States might increase by 1 million barrels per day, is that correct?

Mr. **Bradley**. That's right, sir.

Senator **Melcher**. And you don't have a breakdown of how much would be for fuel for vehicles, cars and trucks, and how much would be for home heating and how much would be for industrial?

Mr. **Bradley**. No, sir, but we will be happy to supply it for the record.

[Subsequent to the hearing the Department of Energy supplied the following:]

The Department of Energy is currently in the process of finalizing a study of future U.S. energy demand and supply. This study is expected to be completed in April of this year, at which time it will be forwarded to the committee.

Department of Energy
Washington, D.C. 20585

May 23, 1983

Honorable James A. McClure
Chairman, Committee on Energy
  and Natural Resources
United States Senate
Washington, D.C. 20510

Dear Mr. Chairman:

On February 21, 1983, George Bradley, Jr., Deputy Assistant Secretary for International Affairs, and Albert Linden, Deputy Administrator, Energy Information Administration, appeared before the Senate Committee on Energy and Natural Resources concerning the World Petroleum Outlook.

On March 4, 1983, we forwarded the edited transcript with inserts to Mr. Al Astrin and stated that additional inserts for the record would be provided as soon as they were available. Enclosed are Inserts for the Record for page 25, line 7 and page 33, line 2. Copies of these inserts have been sent to the Committee staff. This completes our response for this hearing.

If you have any questions, please call Ingrid Nelson or Tom Pretorius of my staff on 252-4277. They will be happy to assist you.

Sincerely,

Thomas H Pretorius
for Robert G. Rabben
Assistant General Counsel
for Legislation

Enclosure

bcc: Mr. Al Astrin
     Committee Staff

Energy Information Administration
Office of Energy Markets
and End Use
U.S. Department of Energy
Washington D.C. 20585

1982 ANNUAL ENERGY OUTLOOK

With Projections to 1990

DOE/EIA-0383(82)
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This report was prepared by the Energy Information Administration, the independent statistical and analytical agency within the Department of Energy. The information contained herein should not be construed as advocating or necessarily reflecting any policy position of the Department of Energy or any other organization.

Preface

Since 1976, the Energy Information Administration (EIA) has provided projections of energy production, supplies, and prices. This year, these projections were produced using a new model, the Intermediate Future Forecasting System (IFFS). This volume, the first issue of the Annual Energy Outlook, replaces Volume 3 of the Annual Report to Congress. (The 1982 Annual Report, describing the activities of the EIA, was published in April of this year.)

EIA is now able to provide yearly projections to 1990, representing individual fuels and end-use sectors, to members of Congress and the public. (Projections for the short term are provided in EIA's quarterly Short-Term Energy Outlook, issued each February, May, August, and November. Each Outlook presents updated energy production, consumption, and price projections for the next 6 quarters.) The 1982 Annual Energy Outlook, like its predecessor, will continue to reflect high professional standards in analyzing the issues, technologies, policies, and economic events that affect the Nation's energy future.

The report was produced by the Longer Term Division in the Office of Energy Markets and End Use.

Released for printing May 10, 1983

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Executive Summary

This report presents an analysis of energy trends and projections for the 1980's, both international and domestic. These forecasts are part of a series of Energy Information Administration analyses dating from 1976.

The report is characterized by two major themes. First, the higher energy prices that occurred in the 1970's result in a projection of lower per capita energy use and greater energy efficiency during the 1980's. Although some energy prices may fall over the next few years, end-use prices are not projected to return to the levels of the early 1970's. Projected consumption levels reflect continued adjustment to the higher general level of energy prices.

Against this background, however, a second important theme involving the relative prices of oil and natural gas emerges. While there has been a substantial movement from oil to (cheaper) natural gas, the projections suggest a reversal of this trend as natural gas becomes more expensive and oil prices fall.

The Oil Market

Trends in the oil market over the first few years of this decade have been dominated by two factors. One is the delayed but inevitable reduction in consumption, which has occurred in response to the sharp increase in the price of international crude oil since 1978. The second is the prolonged worldwide economic recession.

By the end of 1980, the world oil price was over $39 per barrel, up from $8 (1982 dollars) in 1973. The oil-importing countries have responded to this oil price increase with increases in general energy efficiency and substitution, where possible, of alternative fuels for oil. For example, in the major industrial countries, the total-primary-energy to gross-domestic-product (GDP) ratio declined 13 percent between 1973 and 1980, even while GDP itself rose 19 percent in real terms. The oil to GDP ratio fell 20 percent over the same period. These declines reflect basic structural changes in the economies of the countries and will affect energy consumption patterns in the future.

World energy markets in 1982 were characterized by a slack oil market and a decline in world oil prices. At year's end, world oil production capacity exceeded consumption by about 9 to 10 million barrels per day. Substantial liquidation of world oil inventories in 1982 helped further soften world oil prices, which drifted downward from just over $34 per barrel in January to about $33 per barrel in December.

The world oil price, in real terms, is projected to fall through the mid 1980's before increasing in the latter half of the decade. Continued slow economic growth in the industrialized world and growing difficulties in international financial markets, particularly with respect to certain key oil-exporting countries, are expected to help keep oil markets soft over the next few years.

Three alternative oil price projections are developed in this report and are shown in Table E1. The midprice projection, made by analyzing international oil supplies and demands, shows oil prices declining in real terms to a low of $25 a barrel in 1985 before increasing to $37 a barrel in 1990. The high and low price cases result from an assessment of higher and lower growth in demand and less and more optimistic supply assumptions.

Table E1. World Oil Price: History and Projections
(1982 dollars per Barrel)

Price	1982	1983	1984	1985	1986	1987	1988	1989	1990
Low	34	28	23	21	21	22	24	26	28
Mid	34	30	26	25	28	32	34	36	37
High	34	32	30	34	38	41	43	45	48

Domestic oil prices peaked in 1981. This, together with the gathering recession in the United States, caused a rapid decline in the consumption of residual fuel oil and gasoline. Also contributing to the decline was a reduction in distillate oil use as industrial production declined and consumers reacted to prices. By the end of 1982, the prices of all petroleum products were well below the prices 1 year earlier.

Macroeconomic Assumptions

Macroeconomic assumptions are shown in Table E2. Rates of growth in GNP are consistent with these observed during the 1970s, while the GNP price deflator reflects recent reductions in the rate of inflation.

Table E2. Historical and Projected Growth Rates for Selected Economic Aggregates and Population, Middle World Oil Price Case
(Growth Rates per Year, Percent)

	1970-1980	1980-1990	1982-1990
Real Gross National Product	3.1	2.5	3.2
Real Disposable Income	3.1	2.6	2.8
GNP Price Deflator	6.9	6.4	6.1
Population	1.1	0.9	0.9

Source: Historical data: Council of Economic Advisors, Economic Report of the President, transmitted to Congress February 1983, (Washington, D.C., 1983)

The Natural Gas Market

Unlike oil prices, natural gas prices have risen rapidly in the early 1980's. These increases have occurred despite declines in consumption caused by the recent recession. The recent price increases result from the long history of natural gas regulation, certain types of contractual relationships developed under those regulations, and traditional contracting practices.

The Natural Gas Policy Act (NGPA) of 1978 (P.L. 95-621) established a pricing structure which put most gas under price ceilings based on the geology, distance from other wells, location, depth, vintage, and existing contractual arrangements for the gas. The act also created a category of high cost gas free from price ceilings. Price ceilings for new gas were allowed to increase somewhat faster than inflation, but the Act limited increases in the price of old gas. Pipeline companies which had been previously unable to obtain sufficient supplies bid for the uncontrolled gas and signed "take-or-pay" contracts which required most of the gas to be paid for even if not taken by the pipeline.

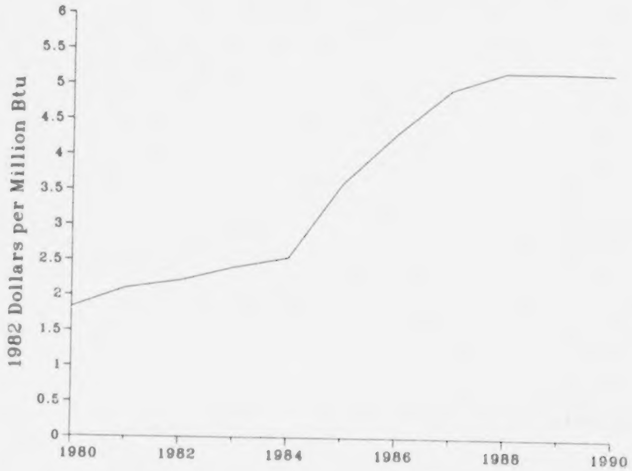
Pipeline companies wholesale most gas to distribution companies. The distribution companies buy gas at the average of all gas contract prices available to that pipeline plus a tariff regulated by the Federal Energy Regulatory Commission. Thus consumers, buying at the average price, did not initially see the higher prices bid by pipelines for unregulated gas. As more high cost gas was included in the mix, prices rose.

In 1985 about half the domestic natural gas production will be free of price controls. The effect of decontrol on prices will probably depend as much on existing contract provisions as upon underlying supply and demand conditions. Some contracts contain provisions providing that, in the event of decontrol, the wellhead price of gas will be established at a price equivalent to distillate fuel oil. A large number of contracts (about 46 percent) contain "most-favored nation" clauses and require that the gas covered by the contract receive a price as high as other producers in the area receive. The extent to which these contract provisions will raise gas prices to artificially high levels is very much uncertain at this point. Nor is it clear that these contracts can survive in a market in which pipelines cannot sell the gas to distributors at the resulting prices. There is some evidence that contracts are being renegotiated.

The prices of natural gas reported in this document reflect the assumption that consumers in many parts of the country will move from natural gas to oil as some petroleum products become less expensive than natural gas. This occurs because gas prices rise in the projections while oil prices are projected to fall. There are, however, significant regional differences in the prices of both natural gas and petroleum products, and these are difficult to completely capture in projections at the national level. The natural gas prices reported here do, however, agree very closely with price projections obtained from more detailed analyses of natural gas markets.

The national average natural gas wellhead price resulting from detailed analysis of the natural gas market is presented in Figure ES1. Through

Figure ES1. U.S. Average Wellhead Price of Natural Gas, Midprice Scenario, 1980 to 1990 (1982 Dollars per Million Btu)



Note: Prices for 1982 through 1990 are projections.

Source: Historical data: Energy Information Administration, 1981 Annual Report to Congress, Volume 2, DOE/EIA-0173(81)/2 (Washington, D.C., 1982).

1984, the average wellhead price of natural gas rises with the legal ceilings for the categories of gas defined by the NGPA and due to changes in the composition of supply towards the higher priced tiers.

By 1985, however, the price of low-sulfur residual fuel oil dips below gas prices in the industrial and electric utility sectors in some regions of the country. While projected natural gas prices continue to rise, the increases are moderated by competition with petroleum products.

Natural gas prices to major industrial and electric utility customers will be competitive in some areas of the countries. Because of differences in transportation costs and relative use in different parts of the country, however, national average prices of the fuels are unlikely to be equal.

The Relative Prices of Gas and Oil

Since World War II, the price of natural gas has remained below the price of oil at the burner tip. In spite of this, much of the energy legislation of the 1970's was predicated on the assumption that natural gas prices would rise to the equivalent of oil prices in an unregulated environment. In the middle oil price projections, the price of low-sulfur residual fuel oil and gas appear to be equalizing in the industrial and utility markets in some areas.

Electric Utilities. Relative prices will determine to a large extent utility consumption of gas and oil. Many large industrial and utility plants are designed to consume both gas and oil and will in fact switch between them depending on the season and market conditions. (In other sectors, the initial capital investment in, for example, a home heating system limits the choice to a single fuel until the system is replaced.)

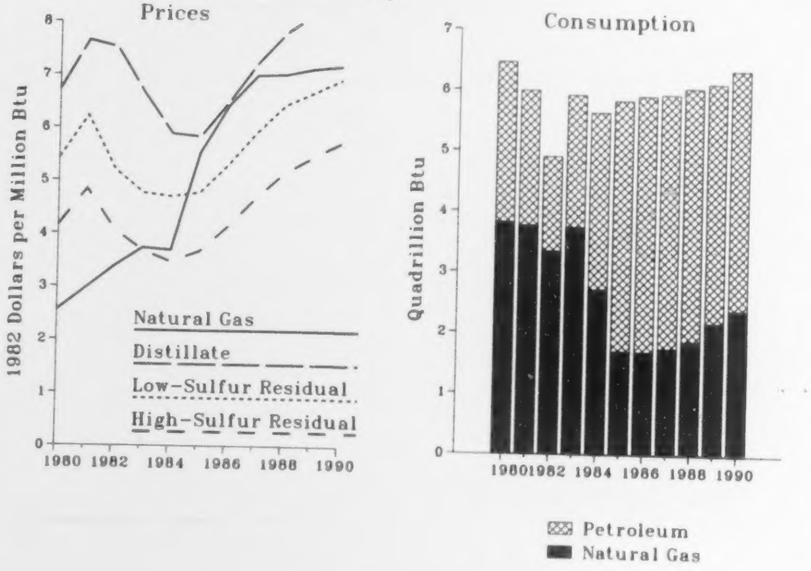
Figure ES2 illustrates the relative average prices of natural gas and low-sulfur residual fuel oil in the utility sector and the resulting decline in gas consumption nationwide.

Electric utilities can respond quickly to relative price changes in two ways: by switching fuels in dual-fired plants that can utilize both gas and residual fuel oil and by using equipment designed to burn a single fuel such as oil or gas more or less intensively.

The effect of lower or higher oil prices is to lower or raise low-sulfur residual fuel oil prices relative to natural gas prices. As low-sulfur residual fuel oil prices decline, utility consumption of fuel oil increases rapidly, by about 2 quadrillion Btu a year (or 1 million barrels of oil a day). The shift can occur because of the large stock of equipment already in existence and able to burn oil.

About three-quarters of the 2 quadrillion Btu shift from gas to oil results from shifting fuels in dual-fired plants mostly located in the West and Southwest. The rest of the change results from using gas-fired plants at lower rates of capacity utilization and oil plants at higher utilization rates.

Figure ES2. Utility Natural Gas and Petroleum Prices and Consumption, Midprice Scenario, 1980 to 1990
(1982 Dollars per Million Btu)
(Quadrillion Btu)



Source: Historical data: Energy Information Administration, State Energy Data Report, 1960 through 1980, DOE/EIA-0214(80) (Washington, D.C., 1982), Monthly Energy Review, DOE/EIA-0035(83/2) (Washington, D.C., 1983), and 1981 Annual Report to Congress, Volume 2, DOE/EIA-0173(81)/2 (Washington, D.C., 1982).

Oil capacity exists and is not currently in use largely due to the response of electric utilities to past oil and gas increases and the slow growth in electricity consumption. The utilities have responded to the general increase in gas and oil prices by the construction of coal and nuclear generation capacity. By 1990 the share of nuclear generation is projected to rise to 19 percent of the total, while the total of oil and gas becomes less important.

Industrial Fuel Use. The industrial sector is the other consuming sector in which there is significant dual-fired capability, which can swing with variations in relative oil and gas prices. A recent EIA survey (DOE/EIA/0358) identified about 1 quadrillion Btu (or a half million barrels of oil per day) of existing capacity in large combustors which could burn both oil and gas. There may also be smaller units with similar capability. In 1979 oil prices were substantially above gas prices and about 80 percent of the energy consumed in these units was gas. More than a one-half quadrillion Btu swing is possible within the range of the price forecasts presented here.

Residential, Commercial, Transportation Fuel Use. While utility and industrial consumption can respond rapidly to differences in the relative prices of gas and low-sulfur residual fuel oil, the situation is different in residential, commercial, and transportation uses.

Since dual-fired capability does not exist to the same degree, changing fuels implies a change in capital equipment as well. Also, these sectors largely use distillate fuel oil rather than residual fuel oil, and this remains more expensive than gas in all the projections. As a result, these sectors exhibit a continuing adjustment to higher gas, oil, and electricity prices, largely by increasing efficiency of use.

Oil Imports

Oil imports may be expected to increase as the economy recovers. In addition, the greater attractiveness of oil relative to natural gas in the industrial and utilities sectors would cause a significant increase in the projected quantity of imported oil. A significant number of utilities are projected to switch from natural gas to low-sulfur residual fuels. This may happen as early as 1984.

In the middle oil price case, projected net imports of crude oil and petroleum products rise from 4.2 million barrels a day in 1982 to 7.6 million barrels a day in 1985 and then fall to 7.1 million barrels a day in 1990 (see Table E3). Some increase in imports is to be expected with economic recovery. However, a large part (about 1.5 million barrels a day in 1985) of the increase is due to switching from natural gas to low-sulfur residual fuel oil in utilities and the industrial sector. If less switching occurs than anticipated, the level of imports could be considerably lower.

Table E3. Net Imports of Crude Oil and Petroleum Products
(million barrels per day)

Case	1975	1980	1982	1985	1990
Middle World Oil Price	5.9	6.4	4.2	7.6	7.1
High World Oil Price	5.9	6.4	4.2	6.0	5.0
Low World Oil Price	5.9	6.4	4.2	8.7	9.5

The General Level of Energy Prices

Despite the decline in the world oil price, the general level of energy prices does not decline in the projections. As Table E4 shows, even in the transportation sector, where petroleum products dominate, prices rise by the end of the period.

Table E4. Average End Use Energy Prices
(1982 dollars per million Btu)

Sector	1975	1980	1985	1990
Residential	5.95	8.33	9.52	11.74
Commercial	6.27	8.38	10.07	12.44
Industrial	3.37	5.44	6.44	8.27
Transportation	6.72	9.91	7.75	10.21

End-Use Consumption

Dramatic changes in energy consumption occurred between 1973 and 1975 and after 1979, as large energy price increases led domestic consumers to use less energy. Because population has increased more rapidly than energy consumption since 1973, per capita use had declined by 14 percent by 1982. To some degree the recent decline in industrial activity contributed to the decrease.

Although energy use on a per capita basis is projected to continue to decline, total energy use is projected to rise modestly through 1990. In the early years, growth is based on economic recovery and relatively stable world oil prices; in the later years, modest growth in personal income, industrial activity, population, and diminished conservation activities contribute to the increase in total energy use.

Table E5. Selected Energy Prices, Middle World Oil Price Case
(1982 Dollars per Million Btu)

Sector/Fuel	1975	1980	1985	1990
Residential				
Natural Gas	2.75	4.16	6.65	8.53
Distillate	4.75	8.59	6.27	9.02
Electricity	15.61	16.78	17.11	18.36
Commercial				
Natural Gas	2.17	3.84	6.42	8.48
Distillate	4.30	8.06	5.94	8.54
Industrial				
Natural Gas	1.49	2.90	5.62	7.23
Low Sulfur Residual Oil	4.11	5.14	4.70	6.95
Transportation				
Distillate	5.85	8.39	6.21	8.95
Gasoline	7.57	11.32	8.69	11.41

Table E5 shows the changes in selected energy prices that explain the modest growth in consumption. Even though oil product prices are projected to decline from 1980 levels, they are projected to remain well above the 1975 values. Other energy prices (natural gas and electricity) continue to rise in the projections.

The shares of total energy consumed by each sector are projected to change somewhat over the decade. In particular, the industrial sector is projected to account for a greater relative share of energy use, largely because energy inputs are used both as heat and power and as direct raw materials (e.g., petrochemical feedstocks), and because of the strong relationships between economic growth and industrial energy use.

Supply of Energy

Except for oil imports, the United States is essentially self sufficient in fossil fuels. A major coal exporter, the United States produced almost all of the natural gas used in 1982, while 68 percent of U.S. oil consumption was domestically produced.

As shown in Table E6, coal production is projected to rise throughout the remainder of the 1980's, from about 830 million tons (19.2 quadrillion Btu) in 1980 to 1080 million tons (23.9 quadrillion Btu) by 1990. In contrast, domestic oil production is projected to remain relatively stable, and then decrease slightly at the of the period. Imports of oil would be expected to rise substantially from 1982 levels with economic recovery. Increased oil consumption is met by increased net imports,

Table E6. Supply and Disposition of Energy
Middle World Oil Price Case

	1975	1980	1982	1985	1990
Supply					
Coal (million tons)					
Domestic Production	655	830	833	914	1080
Stock Withdrawals[a]	-27	-36	-19	0	0
Net Imports	-65	-91	-106	-109	-144
Total Consumption	563	703	708	805	936
Petroleum (million barrels per day)					
Domestic Production	10.0	10.2	10.3	10.0	9.5
Stock Withdrawals[a]	0.5	0.5	0.8	0.4	0.4
Net Imports	5.8	6.4	4.2	7.6	7.1
Total Consumption	16.3	17.1	15.3	18.0	17.0
Natural Gas (trillion cubic feet)					
Domestic Production	19.2	19.4	17.5	14.8	15.9
Stock Withdrawals[a]	-0.6	-0.4	-0.6	0	0
Net Imports	0.9	0.9	0.9	1.2	1.2
Total Consumption	19.5	19.9	17.8	16.0	17.1
Other (quadrillion Btu)					
Domestic Production	5.1	5.7	6.3	7.2	9.5
Net Imports	0.1	0.2	0.2	0.3	0.4
Total Consumption	5.2	5.9	6.5	7.5	9.9
Total Supply (quadrillion Btu)	70.7	75.9	70.9	77.6	81.7
Consumption (quadrillion Btu)					
Residential	9.6	9.3	9.2	9.2	9.3
Commercial	5.5	5.9	5.9	6.6	6.9
Industrial	22.8	24.0	19.9	23.3	25.3
Transportation	18.3	20.3	18.7	19.2	17.5
Generation Losses/Discrep	14.5	16.4	17.2	19.3	22.7
Total Consumption (quadrillion Btu)	70.7	75.9	70.9	77.6	81.7

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[a] Balancing item, includes stock withdrawals and processing gains and losses, the Strategic Petroleum Reserve, production and transmission losses.

which rise from 4.2 million barrels a day in 1982 to 7.1 million barrels a day by 1990 in the midprice projection. Projected natural gas production declines through the middle years of the decade, rising at the end of the period.

Longer Term Projections

This report does not contain independent long-term projections beyond the year 1990, but does review four recent forecasts (1981 vintage).

These forecasts, which reflect higher world oil price assumptions, provide the basis for a discussion of synthetic fuels and industry trends to the year 2000.

Forecast Uncertainties

As is true of all forecasts, many assumptions underlie the analysis. In some cases, where these assumptions have been identified as particularly likely causes of uncertainty in the projections, sensitivity analyses have been performed. The world oil price is one example.

The projections, however, do treat current statutes as given. In particular, this analysis rests on the twin assumptions that the pricing provisions of the NGPA are not modified and that significant renegotiation of natural gas contracts does not occur. The projections also depend upon assumptions regarding the degree of fuel switching possible in the utilities sector and the rate of growth in industrial production. In the midprice case, fairly robust industrial production and a high degree of switching capability has been assumed. The results of modifications of some of these assumptions may be found in Chapter 3 of this report and in the Appendix.

1. Introduction

This edition of the Energy Information Administration (EIA) Annual Energy Outlook presents projections of energy production, consumption, and prices. The report examines both domestic and international energy markets and describes how changes in these markets are likely to evolve through 1990 and beyond. Explicit projections and analysis of the domestic and international markets are presented through 1990. A separate discussion of the more remote future is also included.

This volume differs from EIA's previous intermediate forecasts, presented in the EIA Annual Report to Congress, in that annual projections are provided through 1990. Short-term forecasts are not, however, included in the discussion. The Short-Term Energy Outlook, published each February, May, August, and November, presents and explains projections of energy production, consumption, and prices for the next six quarters.

Organization of the Report

The projections and associated analyses presented in the report are organized in three chapters.

- Chapter 2 - International Energy Markets
- Chapter 3 - Domestic Energy Projections through 1990
- Chapter 4 - Domestic Energy Markets in the Longer Term.

Each of these chapters is self-contained and can be read independently. However, the international chapter contains the analysis that lies behind the world oil prices used as assumptions in Chapter 3.

The analysis presented in this volume rests on a wide variety of assumptions, which, taken together, represent a reasonable assessment of future world prices, economic conditions, and Federal energy programs. The energy projections presented here are therefore conditional: their accuracy depends upon the reliability of the underlying assumptions. The projections are not statements about what will happen in energy markets, but rather descriptions of likely futures based on what was known in February 1983.

In a number of cases the analysis is especially sensitive to a particular assumption or the assumption is itself subject to great uncertainty. Domestic energy projections are, for example, relatively sensitive to the world oil price. Where the projections appear to be particularly affected by an assumption, or where the assumption itself is particularly uncertain, alternative projections have been prepared. Thus the projections to 1990 in Chapter 3 have been made using three different world oil price paths. Similarly, the international chapter attempts to bound world oil price uncertainty by examining its sensitivity to world economic conditions. More alternate cases have been constructed than are discussed in this volume. These additional projections can be found in the Supplement to the volume.

2. International Energy Markets

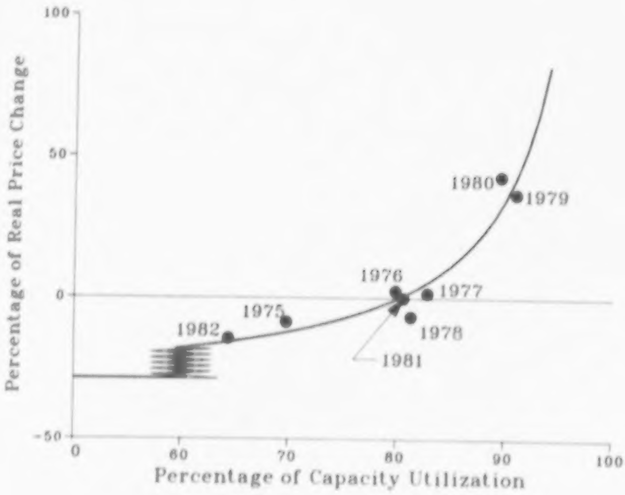
After a decade of relative oil scarcity and rising oil prices, the world appears to be entering a period of oil surplus and falling oil prices. The base case world oil supply and demand situation projected for the rest of the decade implies that the price for world oil, in real terms, could fall through the mid-1980's before beginning to rise again in the latter half of the decade. This means that nominal oil prices could remain relatively stable for the next few years. However, this would still result in a decline in the inflation-adjusted price to roughly $25 per barrel (in constant 1982 dollars) by 1985. The projections of world oil prices discussed here are based on events as of February 1983.

Since 1974, the Organization of Petroleum Exporting Countries (OPEC) has tended to raise prices when the world oil demand for OPEC oil reached roughly 80 percent of its production capacity.[1] The curve in Figure 1 shows OPEC's historical price response to changing demands on its production capacity. OPEC has tended to raise prices sharply whenever demands approach production capacity and allow real prices to drift lower when demands fall. The data points shown in the figure are year-to-year changes in the real price (adjusted for inflation) of oil and the associated utilization rates of OPEC production capacity during the 1974 to 1982 period.

The two major oil price shocks of the 1970's are illustrated in Figure 2. The price increases of 1973-1974 resulted from the oil embargo imposed by the Arab oil-producing countries. The price increases in 1979-1980 followed the Iranian revolution and subsequent reductions in Iranian oil exports. A third shock in oil prices following the outbreak of hostilities between Iran and Iraq in late 1980 was averted by high oil stocks, high levels of unused production capacity within OPEC, and slow economic activity in the industrialized world. The nominal price of world oil, which stood roughly at $4 per barrel in 1973, exceeded $35 per barrel by the end of 1980.

The two major oil price hikes of the 1970's helped initiate the current surplus situation by providing an incentive among the oil-importing countries to initiate programs to increase general energy efficiency and to substitute, where possible, alternative fuels for oil. The ratio measuring the amount of energy needed to produce a given amount of goods and services provides a useful indicator as to the success of these efforts. For the industrialized countries that comprise the Organization for Economic Cooperation and Development (OECD), the total-primary-energy to gross-domestic-product ratio (TPE/GDP) has declined 13 percent between 1973 and 1980, even while GDP itself rose 19 percent, in real terms.[2] The oil/GDP ratio has diminished 20 percent over the same period.[3] Reductions in these ratios undoubtedly reflect basic changes in the economies of the OECD countries that will affect energy consumption patterns for a considerable time. Additional cyclical factors, such as stock withdrawals, weather conditions, and business activity, have acted to reduce oil consumption in 1982 even further than might have been the case given only the influence of more basic structural changes. These effects of short-term market conditions must be accounted for when considering the success of basic changes towards energy efficiency.

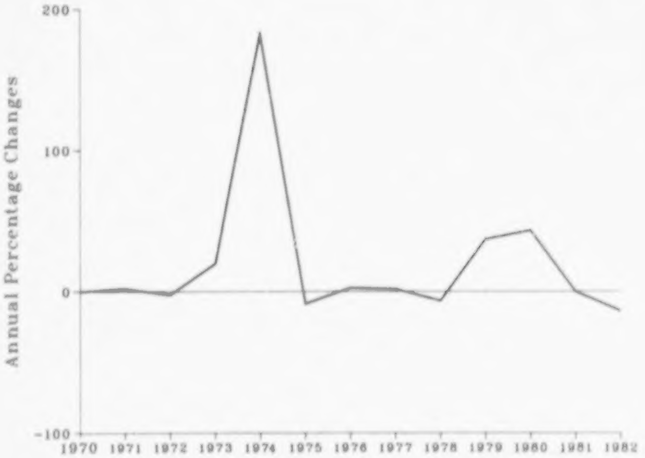
Figure 1. OPEC Pricing Behavior (Percentage Real Price Change from Previous Year vs. Percent of Capacity Utilized)



Note: Production capacity is defined as the maximum production rate that can be sustained for several months. The curve was fitted to historical data using least squares regression.

Sources: Energy Information Administration, Monthly Energy Review, DOE/EIA-0035 (83/02) (Washington,D.C., 1983), International Energy Indicators (Washington, D.C., May 1979); and Central Intelligence Agency, International Energy Statistical Review, selected issues, (Washington, D.C.).

Figure 2. Changes in Real World Oil Prices, 1970 to 1982
(Percentage Change from Previous Year)



Sources: Calculated using 1970-1978 data from: Energy Information Administration, World Oil Market Outlook, unpublished memorandum, February 1981. Data for 1979-1982 from: Short Term Energy Outlook, Volume 1, DOE/EIA-0202, selected issues (Washington, D.C.).

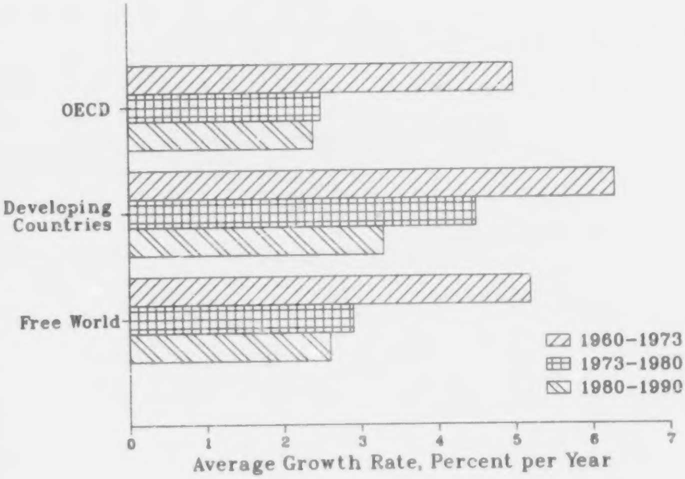
World energy markets in 1982 were dominated by a slack oil market and an associated decline in world oil prices. At year's end, world oil production capacity exceeded consumption by an estimated 9 to 10 million barrels per day. Substantial liquidation of world oil inventories in 1982 helped soften world oil prices, which drifted downward from just over $34 per barrel in January to about $33 per barrel in December.[4] Primary inventories were estimated to be at about 4.8 billion barrels by the end of 1982, or about 102 days' supply compared to 85 days' supply at the outbreak of the Iranian revolution in 1978.[5]

Continued slow economic growth in the industrialized world and growing difficulties in international financial markets, particularly with respect to certain key developing countries, are expected to help keep oil markets soft, at least over the near term. In an economic survey, the International Monetary Fund (IMF) estimates that real economic growth in the industrial world in 1982 will have been less than 1 percent, virtually no growth for the 3rd year in a row. Relatively slow economic growth has also been experienced by the oil-importing developing countries, and actual reductions in economic output in each of the last 3 years have encumbered the oil-exporting countries.[6] Past and projected economic growth rates for industrialized and developing countries are compared in Figure 3.

The tremendous expansion of loans in international financial markets during the 1970's and into the 1980's was in large part fueled by the surplus of funds injected into banking systems by the OPEC nations, funds which were then recycled to developing countries. Problems arose when conservation and recession reduced OPEC surpluses and, additionally, demands for developing country exports needed for repayment of loans. Mexico's difficulties in particular resulted from a combination of rapid expansion of development efforts financed through international loans followed by falling prices for oil and loss of expected revenues. Going into 1983, international financial trends were characterized by dwindling OPEC surpluses linked to falling oil demands, heavy deficits in most of the smaller industrial countries, and rising deficits in the oil-importing developing countries. After years of continuous growth, oil consumption in the oil-importing developing countries of the free world is estimated to have actually declined in 1982.

Changes in world oil prices reflect these changes in world oil market conditions. Three different price paths reflecting different assumptions about future oil market conditions are presented in Table 1. The midprice case was made on the basis of analysis of international oil markets. The projection for 1983 is the base case developed for the February 1983 Short-Term Energy Outlook. The high and low price paths can be considered as an uncertainty range around the midprice case. Uncertainty ranges are estimated to be $21-$34 per barrel in 1985 and $28-$48 per barrel in 1990. The annual price paths shown in Figure 4 do not reflect the additional uncertainty of an oil supply disruption but only general supply and demand pressures generated in the market place. Prediction of any future price shock, its timing, depth, or duration, is considered impossible, and the effects of such an event are discussed separately below.

Figure 3. Free World Economic Growth Rates (Average Growth Rate, Percent Per Year)



Sources: Calculated using data from: Wharton Econometric Forecasting Associates, World Model Historical Data (Philadelphia, Pennsylvania, 1982); and International Bank of Reconstruction and Development, World Tables, Second Edition (Baltimore, Maryland, 1980).

Table 1. World Oil Prices, 1979-1990

Year	Price Case		
	Low	Middle	High
	Real 1982 Dollars per Barrel		
1979	27.48	27.48	27.48
1980	39.32	39.32	39.32
1981	39.27	39.27	39.27
1982	33.59	33.59	33.59
1983	28.00	30.00	32.00
1984	23.00	26.00	30.00
1985	21.00	25.00	34.00
1986	21.00	28.00	38.00
1987	22.00	32.00	41.00
1988	24.00	34.00	43.00
1989	26.00	36.00	45.00
1990	28.00	37.00	48.00
	Nominal Dollars per Barrel[a]		
1979	21.67	21.67	21.67
1980	33.89	33.89	33.89
1981	37.05	37.05	37.05
1982	33.59	33.59	33.59
1983	29.00	31.00	33.00
1984	25.00	29.00	33.00
1985	24.00	29.00	40.00
1986	26.00	34.00	47.00
1987	29.00	42.00	54.00
1988	34.00	48.00	60.00
1989	39.00	54.00	67.00
1990	45.00	59.00	77.00

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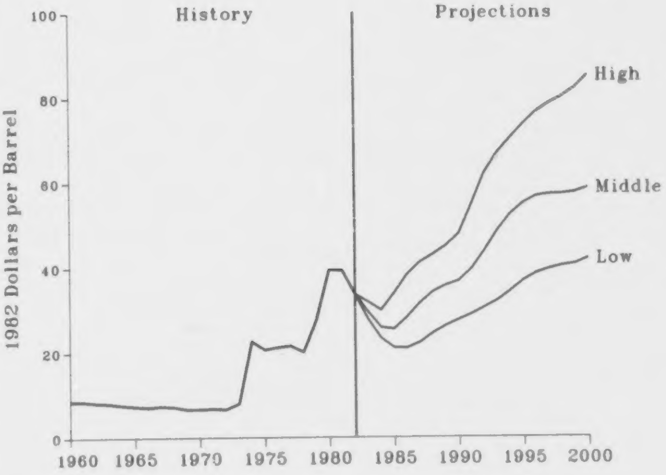
[a] Inflation rates used to estimate nominal prices are given in Chapter 3.

Source: Historical data: Energy Information Administration, Monthly Energy Review, DOE/EIA-0035 (82/12) (Washington, D.C., 1982), and Short-Term Energy Outlook, Volume 1, DOE/EIA, 0202 (83/1Q) (Washington, D.C., 1983).

Figure 4. World Oil Price Projections, High, Middle, and Low World Oil Price Scenarios, 1960 to 2000 (1982 Dollars per Barrel)



Note: All prices reflect the average landed price of crude oil in the United States.

Sources: Historical data for 1960–1978: Energy Information Administration, World Oil Market Outlook, unpublished memorandum, February 1981. Data for 1979–1982 from: Energy Information Administration, Short-Term Energy Outlook, Volume 1, DOE/EIA-0202, selected issues (Washington, D.C.).

The midprice case projection has prices falling in real terms (1982 dollars) from $34 per barrel in 1982 to $25 per barrel in 1985 and then rebounding to $37 per barrel by 1990. The projected continuation of falling prices for the next few years is caused by the current 9 to 10 million barrel per day excess in world oil production capacity and the outlook for relatively weak economic growth for the remainder of the decade. Prices are projected to climb steadily after 1985, as available supplies constrain growing demands. Given projected inflation rates, prices in nominal dollars under the midprice case would be $29 in 1985 and $59 in 1990.

As stated above, the price paths in Figure 4 do not include any sudden disruptions in the supply of oil over the next 18 years and are, therefore, relatively smooth over time. This pattern is in contrast to the sharp price increases--followed by price declines--experienced in the past. Future prices might also not follow such a smooth course over time. The possible reaction of prices to a hypothetical supply disruption in 1984 equivalent to a closure of the Straits of Hormuz is illustrated in Figure 5. This reduces world oil production capacity by 16 million barrels per day and actual production by 5 million barrels per day below its 1983 level. The reduction results in a hypothetical market-clearing price of $76 per barrel in 1984, but prices fall steadily when supplies are restored. Prices then oscillate around the no-disruption midprice case price path until they settle back to the long-term equilibrium trajectory.

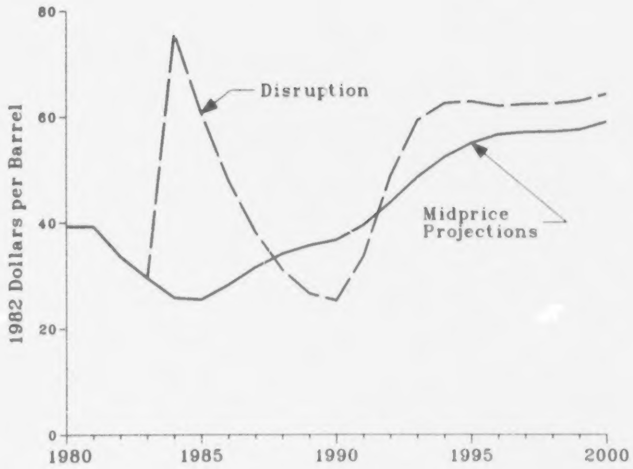
Oil Demand and Supply

Table 2 shows projected oil consumption and production under the midprice case. Oil consumption in the industrialized countries of the OECD, excluding Australia and New Zealand, grows at an annual rate of 1.5 percent between 1981 and 1985 but then slows to an annual rate of about 0.2 percent between 1985 and 1990. Lower world oil prices encourage consumption through 1985, with the fastest rate of growth occurring between 1983 and 1985. Increasing oil prices and continued efforts at energy efficiency and fuel switching discourage growth in oil consumption in these countries after 1985, with consumption in the United States projected to actually decline through 1990.

Oil consumption in the developing countries of the free world is projected to remain virtually flat through 1983 and then to grow steadily for the rest of the projection period. The OPEC countries, with abundant supplies, are projected to increase their level of oil consumption by more than a third between 1981 and 1990. Oil consumption in the non-OPEC developing countries is projected to increase by about 20 percent between 1981 and 1990. A problem for many of these countries will be their inability to generate the capital needed to develop alternative energy sources. Oil consumption in the developing countries is projected to exceed that of Western Europe by 1983. Projected oil consumption in the free world is illustrated in Figure 6.

Oil production in the free world, at a level of about 42.8 million barrels per day in 1982, is projected to rise steadily to about 53 million barrels per day by 1990 (see Figure 7). Production in the OPEC countries is also

Figure 5. World Oil Prices With Hypothetical Disruption in Supply, 1980 to 2000 (1982 Dollars per Barrel)



Note: Data for 1983 through 1990 are projections.

Note: The disruption price path is based on a hypothetical disruption occurring in 1984 that reduces world oil production capacity by 16 million barrels per day and actual production by 5 million barrels per day below the 1983 level.

Table 2. Free World Oil Consumption and Production,[a] History and Midprice Case Projections
(Million Barrels per Day)

	1980	1982	1985	1990
Consumption				
United States[b]	17.5	15.6	18.4	17.4
Canada	1.9	1.7	1.9	2.0
Japan	5.0	4.5	4.9	5.3
OECD Europe	13.5	11.9	12.8	13.5
OPEC	2.6	2.9	3.2	3.9
Other Countries[c]	9.0	8.8	9.7	10.7
Total Consumption	49.6	45.4	50.8	52.8
Production				
United States	10.8	10.8	10.6	10.0
Canada	1.8	1.6	1.5	1.7
OECD Europe	2.6	3.0	3.4	3.0
OPEC	27.6	19.8	25.8	27.7
Other Countries	6.4	7.6	8.8	10.2
Total Production	49.1	42.8	50.1	52.6
Net Exports from Centrally Planned Economies	1.2	1.5	1.0	0.5
Stock Change and Discrepancies	-0.7	-1.1	0.3	0.3

[a] Includes crude oil, natural gas liquids, refinery gains, hydrogen, and other hydrocarbons.

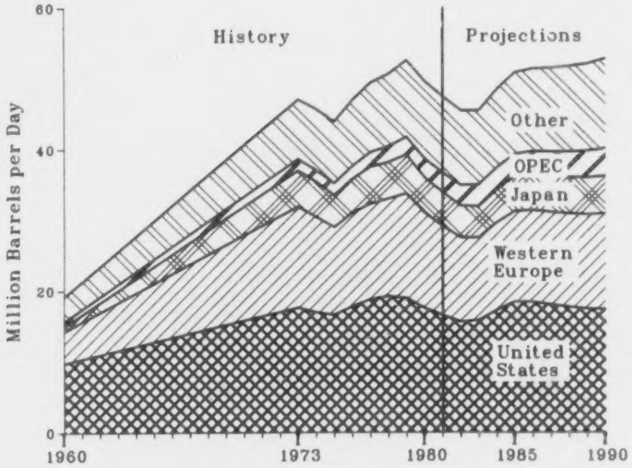
[b] Includes Puerto Rico and Virgin Islands.

[c] Excludes Centrally Planned Economies.

Note: Numbers may not add to total because of rounding.

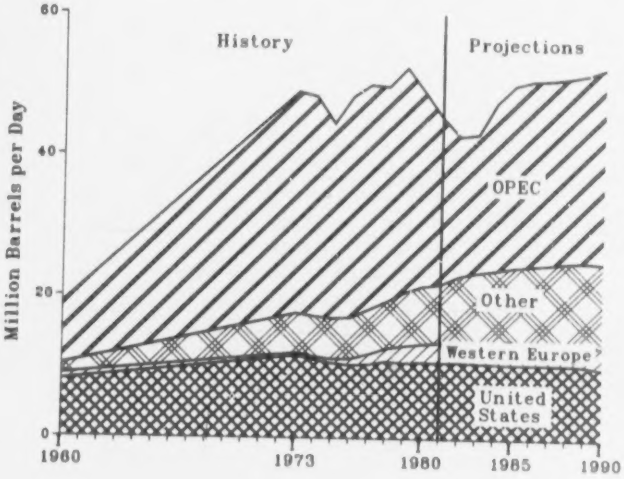
Source: Historical Data: Energy Information Administration, 1981 Annual Report to Congress, DOE/EIA-173(81)/3 (Washington, D.C., 1982); Monthly Energy Review, DOE/EIA-0035 (82/11), and 1981 International Energy Annual, DOE/EIA-01219(82); Organization for Economic Cooperation and Development/International Energy Agency, Quarterly Oil Statistics, Second Quarter 1982, (Paris, France, 1982); and Petroleum Economics Limited, Quarterly Supply/Demand Outlook, (London, England, 1982).

Figure 6. Free World Oil Consumption, Midprice Scenario, 1960 to 1990 (Million Barrels per Day)



Source: Historical data: Energy Information Administration, 1981 Annual Report to Congress, Volume 2, DOE/EIA-0173(81)/2, Monthly Energy Review DOE/EIA-0035(82/11), International Petroleum Annual DOE/EIA-0042(78), and 1981 International Energy Annual DOE/EIA-0219(81) (Washington, D.C., 1982); and Organization for Economic Cooperation and Development, Quarterly Oil Statistics, Second Quarter 1982 (Paris, France 1982).

Figure 7. Free World Oil Production, Midprice Scenario, 1960 to 1990 (Million Barrels per Day)



Note: Includes natural gas liquids and synthetic liquids.

Source: Historical data: Energy Information Administration, 1981 Annual Report to Congress, Volume 2, DOE/EIA-0173(81)/2, Monthly Energy Review DOE/EIA-0035(82/11), and 1981 International Energy Annual DOE/EIA-0219(81) (Washington, D.C., 1982); and Organization for Economic Cooperation and Development, Quarterly Oil Statistics, Second Quarter 1982 (Paris, France 1982).

expected to be at its lowest level in 1982, at about 20 million barrels per day. Production is then projected to rise to about 28 million barrels per day by 1990, which is still well below the 1977 peak of 31 million barrels per day.

Other than from OPEC, a large share of the increase in oil production through 1990 is projected to come from the developing countries. Mexico is by far the largest producer among these countries and should remain a major contributor to world oil supplies. Other countries in this group that are currently producing 100,000 barrels per day or more include Argentina, Brazil, Columbia, Peru, Trinidad and Tobago, Oman, Syria, Angola, Egypt, Tunisia, Brunei, India, and Malayia. In addition, ethyl alcohol is expected to become an important source of liquid fuels for Brazil. Oil production from the developing countries is projected to rise about 34 percent between 1982 and 1990.

Oil production from the OECD countries is expected to remain relatively flat over the projection period. Declining supplies from mature fields will be replaced by new oil supplies coming primarily from the North Sea and offshore areas of the United States and Canada. Additional gains to liquid fuel supplies are expected from enhanced oil recovery, shale oil, and synthetic liquids.

World Energy Consumption

Though total oil consumption in the free world is projected to remain below its 1979 level of about 52.5 million barrels per day until 1990, total energy consumption is projected to continue to grow. Fuels expected to contribute a growing share of world energy consumption include coal, nuclear power, hydroelectric power, synthetics, solar power, geothermal heat, and biomass.

Total energy consumption in the free world is projected to increase from about 200 quadrillion Btu in 1980 to about 229 quadrillion Btu by 1990 (see Table 3). All regions of the free world contribute to the projected increase, but the OECD Pacific region and the developing countries (including the OPEC countries) are projected to experience the fastest rates of growth over the decade. By 1990, energy consumption in these areas is projected to be about 20 percent and 36 percent above 1980 levels, respectively. For the free world as a whole, total energy consumption in 1990 is projected to be 15 percent higher than it was in 1980.

Though energy consumption in North America is expected to grow at a slower rate than total free world consumption throughout the projection period, it will continue to account for a large share of free world energy consumption (see Figure 8). Its share of total energy consumption goes from 43 percent in 1980 to 40 percent by 1990.

OECD Europe's share of total energy consumption is also projected to decline steadily over the projection period, going from 27 percent of total consumption in 1980 to about 26 percent in 1990. In contrast,

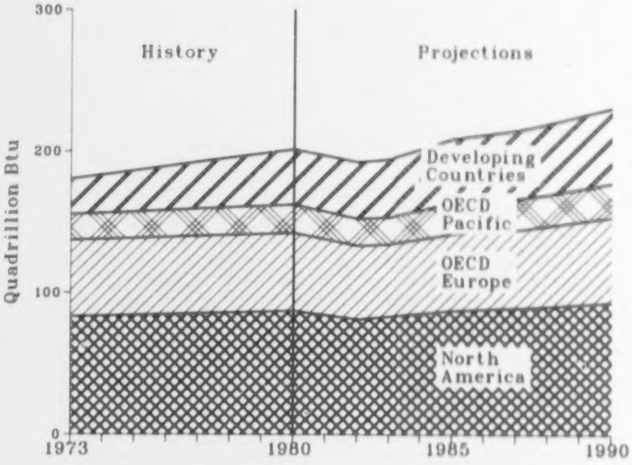
Table 3. Free World Apparent Energy Consumption, History and Midprice Case Projections (Quadrillion Btu)

Region	1980	1985	1990
Total OECD	161	162	176
North America	87	87	92
OECD Europe	55	54	60
OECD Pacific	20	21	24
Developing Countries	39	45	53
Total Free World	200	207	229
Fuel			
Oil	103	104	109
Natural Gas	38	35	37
Coal	38	43	51
Nuclear	6	9	14
Other	15	16	18
Total	200	207	229

Note: Numbers may not add to totals because of rounding.

Sources: Historical data: Derived from Energy Information Administration, 1981 International Energy Annual DOE/EIA-0219(81) (Washington, D.C., 1982), and Monthly Energy Review DOE/EIA-0035 (83/01) (Washington, D.C., 1983).

Figure 8. Free World Consumption of Energy, by Regions, Midprice Scenario, 1973 to 1990 (Quadrillion Btu)



Source: Historical data: Energy Information Administration, 1981 Annual Report to Congress, Volume 2, DOE/EIA-0173(81)/2 (Washington, D.C., 1982), and 1981 International Energy Annual DOE/EIA-0219(81) (Washington, D.C., 1982).

energy consumption in the developing countries is projected to rise from about 20 percent to about 23 percent by 1990. The OECD Pacific share remains around 10 percent over the projection period.

Expectations about growth in energy consumption are influenced primarily by expectations about economic growth. Relatively high rates of growth are anticipated for certain developing countries. Many of the oil exporters among these countries are attempting to use their energy resources as a base for industrial growth. Relatively rapid growth is also anticipated in other semi or newly industrialized countries such as Mexico, Brazil, South Africa, and Hong Kong. However, many of these countries must overcome difficult economic problems in the near term to reach their potential. Export growth will be a key ingredient to economic growth in many areas, such as South Korea, Taiwan, and Singapore. Economic growth is expected to be more moderate in the industrialized countries. Consumption in these regions is also expected to be held down by efforts to increase energy efficiency and conservation.

Fuel Shares

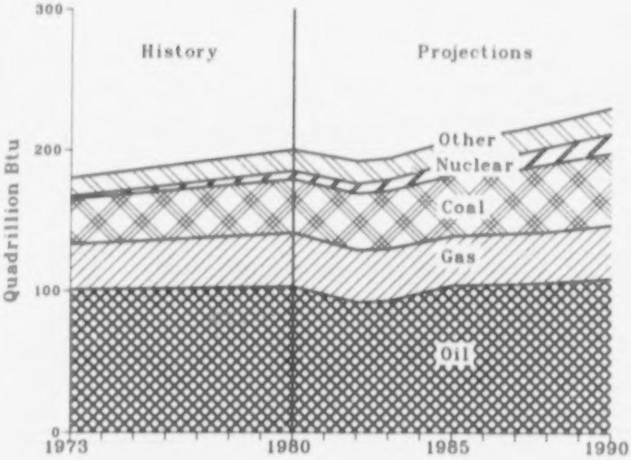
Though consumption of oil is projected to begin to grow again in absolute terms in 1984, its share of total energy consumed is projected to continue to decline during the 1980's. Accounting for over half of all energy consumed in 1980, oil's share is projected to slip to 48 percent by 1990 (see Figure 9). Oil's declining share of total energy consumption reflects its growing scarcity and rising price relative to other energy sources. Like oil, the share of energy coming from natural gas is expected to decline over the next decade, going from about 19 percent of total consumption in 1980 to about 16 percent in 1990.

An increasing share of energy consumed is projected to come from coal, nuclear power, and other energy sources such as hydroelectric power. Coal is projected to increase its share steadily over the decade, going from 19 percent of the total in 1980 to about 22 percent by 1990. The share of energy from nuclear power is projected to double between 1980 and 1990, going from 3 percent to 6 percent of the total. The share of energy derived from all other sources remains around 8 percent through the projection period.

Coal consumption is projected to increase from about 38 quadrillion Btu in 1980 to about 51 quadrillion Btu by 1990. Unlike oil, coal is abundant in many industrialized countries and, as a result, its price should remain relatively low. Major producers and exporters of coal include the United States, Australia, South Africa, India, Poland, the Soviet Union, and China. Increased use of coal is expected as it displaces large quantities of oil as fuel for electric power generation and for industrial use. It will also serve to fuel economic growth in the newly industrialized countries of the world. Another growing use for this resource is expected to be coal liquification.

Consumption of natural gas is projected to decline from 38 to 35 quadrillion Btu between 1980 and 1985 and then to climb back up to 37 quadrillion Btu by 1990. Most natural gas consumption is projected to occur in the regions in which it is produced. Growth in natural gas

Figure 9. Free World Consumption of Energy, by Type of Energy, Midprice Scenario, 1973 to 1990 (Quadrillion Btu)



Source: Historical data: Energy Information Administration, 1981 Annual Report to Congress, Volume 2, DOE/EIA-0173(81)/2 (Washington, D.C., 1982), and 1981 International Energy Annual DOE/EIA-0219(81) (Washington, D.C., 1982).

Table 4. Free World Nuclear Generating Capacity, 1981-1990 (Gigawatts-electric)

Year	United States	Other OECD	Non-OECD	Total
1981	55	79	5	139
1985	72-90	107-115	10-13	189-218
1990	112-121	145-170	21-31	278-322

Source: Energy Information Administration, Nuclear and Alternate Fuels Division (Washington, D.C., 1983).

exports will depend upon the development of long-distance pipelines and liquefied natural gas (LNG) facilities, both of which require large investment commitments.

Nuclear energy consumption is projected to grow from about 6 quadrillion Btu in 1980 to about 14 quadrillion Btu in 1990, a growth rate of almost 9 percent per year. By comparison, coal is projected to grow at an average annual rate of about 3 percent per year and oil at under 1 percent per year. Total energy consumption is projected to grow somewhat over 1 percent per year in the 1980's.

Projections of free world nuclear generating capacity are presented in Table 4. Nuclear power is expected to play an important part in meeting future growth in electricity demands in the industrialized world, particularly in Canada, France, West Germany, Japan, and the United States. Countries outside the OECD with significant nuclear plans include Argentina, Brazil, India, South Korea, South Africa, and Taiwan. Factors that will influence future nuclear development include growth in overall demand for electricity, the cost of plant and equipment, and the ability to confront waste management and other safety related problems.

The projections of energy consumption presented here are based on the assumption that the Centrally Planned Economies (CPE) will continue to be net exporters of energy. In 1981, the Soviet Union was the world's largest producer of oil, with an output of about 12.3 million barrels per day. This amount compares with 1981 output levels of 10.2 million barrels per day for the United States and for Saudi Arabia. In addition to production for domestic use, the Soviet Union is expected to provide important amounts of natural gas to Western Europe by the late 1980's. The Soviet Union and People's Republic of China are also major world producers of coal.

Comparison of International Energy Projections

The EIA midprice projections of energy consumption and oil consumption and production by region for 1990 from the EIA 1977 Annual Report to Congress through the current edition of the Annual Energy Outlook are presented in Table 5. Projections of 1990 energy consumption and production have dropped considerably and consistently since the 1977 Annual Report, including those for this year. Energy projections for the Annual Energy Outlook are lower than those in the 1981 Annual Report for all regions except for OECD Europe. The projection for total free world energy consumption is down about 4 percent. Projections of energy consumption for the United States and Japan have been reduced considerably this year. Lower energy projections in these countries reflect lower expectations about future economic growth and greater expectations about future energy savings.

Though total energy consumption for 1990 in the United States has been lowered this year, projected 1990 consumption of oil in the United States has been increased by about 6 percent. Projected 1990 oil consumption for the rest of the OECD countries, excluding Japan, has also been increased, up 14 percent. Total projected free world 1990 oil consumption is up 5 percent. An important reason for the higher estimates this year is the difference in the outlook for world oil prices. The projected 1990 world oil price, in 1982 dollars, is currently $37 per barrel, which is $14 per barrel below last year's projection.

Higher 1990 oil consumption in the Annual Energy Outlook is coupled with higher oil production. OPEC provides the bulk of the difference in production levels. Also of interest is the assumption of a net export of oil from the Centrally Planned Economies (CPE). In previous years, the midprice case carried the assumption of a balance in CPE oil exports by 1990, except for the 1977 Annual Report which assumed net imports by the CPE countries of 2.5 million barrels per day.

Other International Energy Projections

Table 6 compares EIA projections with recent projections published by other organizations. The projections are, of course, based on different assumptions about such factors as energy resources, economic growth rates, and world oil prices. Important differences in underlying assumptions are noted to help explain differences in the respective projections.

The range for projected total 1985 energy consumption in the free world is 8 million barrels per day of oil equivalent, and the range for 1990 is 11 million barrels per day. The range for oil consumption is 4 million barrels per day for 1990. The International Energy Agency (IEA) in Paris (under its high oil demand case) projected oil consumption as high as 56 million barrels per day for 1990, but this amount assumes an excess of demand over available supplies of 4 million barrels per day. Such an excess would have to be eliminated by accelerating world oil prices.

Projections of oil and energy consumption are lowest in the Tenneco study. Their projections are based on economic growth rates for the free world of 3.5 percent between 1980 and 1985 and 2.7 percent between 1985 and 1990. Tenneco assumes that rising energy prices, conservation, and technological advances will significantly lower energy consumption per unit of gross output.

Table 5. Comparison of Projections from 1977 through 1981 EIA Annual Report to Congress and 1982 Annual Energy Outlook: Middle Price Scenario, 1990

Element of Comparison	United States	Japan	OECD Europe	Other Countries	Free World
Energy Consumption (quadrillion Btu)					
1977 Annual Report	109	33	82	97	321
1978 Annual Report	103	26	67	85	280
1979 Annual Report	90	24	57	76	247
1980 Annual Report	88	24	59	74	246
1981 Annual Report	87	23	59	70	238
1982 Annual Energy Outlook	82	19	60	69	229

	United States[a]	Japan	Other OECD	Other Countries	Free World
Oil Consumption (million barrels per day)					
1977 Annual Report	24.2	11.5	26.5	21.0	83.2
1978 Annual Report	19.9	7.9	21.1	19.8	68.7
1979 Annual Report	16.0	6.3	15.0	15.3	52.6
1980 Annual Report	16.0	5.5	14.3	14.4	50.4
1981 Annual Report	16.2	5.5	14.3	14.4	50.4
1982 Annual Energy Outlook	17.4	5.3	16.3	13.8	52.8

	United States[a]	OPEC	Other Non-OPEC	Imports from CPE[b] Countries	Free World
Oil Production (million barrels per day)					
1977 Annual Report	10.1	61.0	14.6	-2.5	83.2
1978 Annual Report	11.5	39.7	17.5	0	68.7
1979 Annual Report	9.9	26.3	16.4	0	52.6
1980 Annual Report	10.1	26.1	16.3	0	52.5
1981 Annual Report	10.1	25.7	14.5	0	50.4
1982 Annual Energy Outlook	10.0	27.7	14.9	0.5	53.1

[a] Includes Puerto Rico, the Virgin Islands, and refinery gains.

[b] CPE = Centrally Planned Economies.

Note: Rows may not add to totals because of rounding. In 1982 dollars, the world oil price of a barrel of oil was reported as $19 in the 1977 Annual Report, $23 in the 1978 Annual Report, $42 in the 1979 Annual Report, $46 in the 1980 Annual Report, $51 in the 1981 Annual Report, and $37 in the 1982 Annual Energy Outlook.

Table 6. Free World Energy Projections: Comparison of EIA Midprice Projections with Other Projections for 1985-1990 (Million Barrels per Day of Crude Oil Equivalent[a])

	Consumption		Oil Production		CPE Net
	Energy	Oil	OPEC	Other	Oil Exports
1980 Actual	94	50	28	21	1.2
1985 Projections					
EIA	98	51	26	24	1.0
Gulf (February 1982)	101	48	25	24	(1.3)
Socal (June 1982)	105	48	22[b]	21[b]	NA
PPA/DOE (August 1982)	104	50[c]	26	24	0.1
Tenneco (August 1982)	97	47	NA	NA	NA
IEA, Paris (October 1982)	NA	48-50	23-26	24-25	1.0-(1.0)
Conoco (February 1983)	100	47	21	25	0.8
1990 Projections					
EIA	109	53	28	25	0.5
Gulf (February 1982)	116	51	28	25	(2.0)
Socal (June 1982)	118	49	22[b]	22[b]	NA
PPA/DOE (August 1982)	115	52[c]	29	24	(1.0)
Tenneco (August 1982)	107	49	NA	NA	NA
IEA, Paris (October 1982)	NA	50-56[d]	27-29	23-25	0-(2.0)
Conoco (February 1983)	112	49	23	25	0.5

NA = not available.

[a] Crude oil equivalent = 5.8×10^6 Btu/bbl. Conoco uses the factor 5.7.

[b] Excludes 4.1 and 4.5 million barrels per day oil equivalent of natural gas liquids for 1985 and 1990, respectively.

[c] Includes coal and biomass liquids.

[d] Includes 0-4 million barrels per day of excess demand.

Note: Numbers in parentheses are net imports. Rows may not add to totals because of rounding.

Sources: Gulf, Non-Communist World Energy Consumption, (Pittsburgh, Pa., 1982); Standard Oil Company of California, World Energy Outlook (San Francisco, Ca., 1982); Office of Policy, Planning and Analysis, Energy Projections to the year 2000: July 1982 Update (Washington, D.C., 1982); Tenneco, Energy 1982-2000 (Houston, Texas, 1982); International Energy Agency, World Energy Outlook (Paris, France, 1982); Conoco, World Energy Outlook through 2000 (Stamford, Ct., 1983).

The highest levels of 1985 and 1990 energy consumption are those projected by Socal. Their assumptions about economic growth are high relative to the other studies. Economic growth for the free world is assumed to be 3.5 percent per year between 1980 and 1990. The comparable rates assumed by EIA are 2.0 percent between 1980 and 1985 and 3.2 percent between 1985 and 1990. The highest oil consumption projections, other than those by EIA, are those by the Department of Energy's Office of Policy, Planning and Analysis. Free world growth rates underlying those projections are 3.0 percent between 1980 and 1985 and 3.6 percent between 1985 and 1990. In terms of production, OPEC is projected to remain the major supplier of internationally traded oil throughout the decade in all the projections.

Footnotes to Chapter 2

[1] The OPEC members are Algeria, Ecuador, Gabon, Indonesia, Iran, Iraq, Kuwait, Libya, Nigeria, Qatar, Saudi Arabia, the United Arab Emirates, and Venezuela.

[2] The OECD members are Australia, Austria, Belgium, Canada, Denmark, Finland, France, West Germany, Greece, Iceland, Ireland, Italy, Japan, Luxembourg, the Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, Turkey, the United Kingdom, and the United States.

[3] International Energy Agency, World Energy Outlook, April 1982. (Paris, France, 1982).

[4] Average Prices (FOB) weighted by estimated export volume. U.S. Department of Energy, Energy Information Administration, Weekly Petroleum Status Report, December 10, 1982. DOE/EIA-0208(82-49) (Washington, D.C., 1982).

[5] U.S. Department of Energy, Energy Information Administration, Short-term Energy Outlook, DOE/EIA-0202(83/1Q), February 1983. (Washington, D.C., 1983).

[6] International Monetary Fund, World Economic Outlook, April 1982. (Washington, D.C., 1982).

3. The Outlook for Domestic Energy Markets Through 1990

Energy markets in the United States have undergone dramatic changes since the end of World War II. During the postwar period the Nation shifted from a general dependence on coal as the primary fuel to increasing reliance on natural gas and oil. Supplies of these fuels were abundant and inexpensive. Consumers preferred them to other fuels because they were clean, convenient, and economical. By the end of the 1960's, however, domestic production of oil and gas began to level off and the Nation was becoming more and more dependent upon imported energy. The significance of that reliance and the vulnerability of the United States to disruptions of supply and abrupt changes in price became apparent in 1973 when the Arab members of OPEC embargoed oil shipments to the United States. The embargo and accompanying price changes caused oil consumption and imports to decline during the next 2 years. Although domestic oil consumption had again begun to grow in 1976, the growth ceased in 1979 when oil prices doubled.

Although the future price of oil is very uncertain, it has become clear that a return to the energy prices that prevailed in the 1960's and before is not likely. Individuals and firms have long since begun to make appropriate adjustments in response to higher energy prices. At first short-term changes (reductions in the amount of driving, for example) began to be made. More gradually, changes toward more energy-efficient houses, cars, and factories, and adjustments towards less expensive fuels occurred.

These changes do not take place instantaneously, however, but are spread over a number of years. Nor do they take place in isolation. Many variables affect the rate at which adjustments are made.

For example, the level of investment influences the rate at which new (and presumably more energy-efficient) industrial plants are built. Interest rate levels influence the rate of new home construction and new car sales, and hence the degree to which the stock of homes and autos reflect more recent energy prices. The speed at which adjustments to the higher energy prices can be expected to take place is thus affected by the more general economic environment. Some of these relationships will be explored in this chapter.

Against this background of continuing adjustment to higher prices, consumption decisions are also made based upon the relative prices of oil and of natural gas. While oil prices are projected to fall over the next few years, the prices of gas are projected to increase. While individuals and firms have been moving from oil to gas in the recent past, a new pattern of oil and gas consumption may be emerging.

This chapter describes the changes in energy consumption and production underway in domestic energy markets, the forces behind these changes, and projections of the way in which these forces will affect energy production and use over the rest of the decade. The discussion is organized into five parts:

- Three key assumptions
- End-use consumption of energy
- Electric utilities and the production of electricity
- Primary energy (oil, natural gas, and coal) production
- An essay on the relationship between the energy sector and the more general economy.

A concluding section provides a comparison of the forecasts in this chapter with other recent projections.

Assumptions

A great many specific assumptions about behavior and the state of the world underlie the forecasts presented in this chapter. A description of most of these specific assumptions may be found in the Supplement to this volume. Three assumptions, however, are of central importance in determining the general shape of the projections--assumptions about the world oil price, the state of the economy, and the general state of Federal regulation.

World Oil Price

The world oil price trajectories underlying the base (or middle world oil price) projections are shown in Table 7, together with high and low world oil price trajectories. Events in the world oil market over the past two years (and even the past few months) have led to a projection of world oil price that is 35 percent lower in 1990 than the assumption employed in the 1981 Annual Report to Congress. More generally, the year to year swings in the real price of oil since 1970 demonstrate the extreme degree of uncertainty surrounding world oil prices.

The bands of uncertainty around the price paths and the underlying assumptions are discussed in Chapter 2, International Energy Markets. It is important to note that the paths employed here reflect smoothly varying supply and demand pressures and changes from one year to the next. Future prices may not rise in such a smooth fashion. As in the past, prices may rocket upward suddenly (perhaps due to a supply interruption or conflict in a major supply region) followed by periods of gradually declining prices (in real terms) during the slack markets that have followed disruptions.

Macroeconomic Assumptions

The macroeconomic assumptions underlying the projections in this volume also differ from those employed in previous years. In the past, a particular forecast obtained from a single forecaster (e.g., Data Resources, Inc., Chase Econometrics) was used. This year two different forecasts, one

Table 7. World Oil Price Projections
(1982 Dollars per Barrel)

Price	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Low	39	34	28	23	21	21	22	24	26	28
Middle	39	34	30	26	25	28	32	34	36	37
High	39	34	32	30	34	38	41	43	45	48

from Data Resources, Inc., and one from Dale Jorgenson Associates were employed to generate macroeconomic assumptions. These assumptions constitute input data for projections of energy markets and are not, in any sense, an independent EIA forecast of the economic future.

Table 8 presents values of important economic variables. Basically the macroeconomic assumptions are straightforward. Gross National Product--the total value of goods and services produced by the economy in a year--increases over the forecast period (1982-1990) at a rate of 3.2 percent a year, more rapidly during the initial years as the economy recovers. The overall rate of increase is somewhat below the rate of 3.5 percent that prevailed during the period between 1947 and 1980, but about the same as the overall rate of 3.2 percent that occurred during the 1970's. It is considerably above the rate of 1.8 percent observed between 1973 and 1982. The rate of growth assumed is in keeping with the recent trends in the economy.

The energy and economic values used in this report are expressed in constant 1982 dollars. In other words, the projected value of energy services in some future year is expressed in terms of the number of 1982 dollars required to purchase the services. The index used to convert current prices to constant dollar prices is the "implicit price deflator" for GNP--the ratio of GNP in current dollars to GNP in constant dollars.

The GNP deflator is only one of a number of measures of inflation; others include the Producer Price Index and the Consumer Price Index. The GNP deflator is employed here because of its broad base and the ubiquity of energy use in the economy. Over the 1980 to 1990 period, the GNP deflator is assumed to increase relatively smoothly at a rate of 6.4 percent. This rate is somewhat below the rate of 7.8 percent experienced since 1973 and reflects recent decreases in inflation.

Disposable income and interest rates are other variables that play important roles in determining energy demands in different sectors of the economy. The level of disposable income is an important determinant of personal energy use. Historical and projected values for these variables are shown in Table 8.

Table 8. Assumed Values of Macroeconomic Variables

Variable	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Real GNP (billions of 1982 dollars)	3,054.4	3,113.8	3,057.6	3,111.0	3,253.4	3,394.4	3,505.5	3,614.3	3,705.7	3,804.5	3,920.4
Percentage Change	-0.4	1.9	-1.8	1.7	4.6	4.3	3.3	3.1	2.5	2.7	3.0
Disposable Income (billions of 1982 dollars)	2,109.7	2,161.5	2,185.1	2,228.2	2,332.9	2,420.5	2,495.3	2,551.5	2,592.7	2,653.1	2,719.2
Percentage Change	0.2	2.5	1.1	2.0	4.7	3.8	3.1	2.3	1.6	2.3	2.5
GNP Deflator (1972 = 100)	178.6	195.5	207.2	216.7	227.8	240.3	254.4	271.1	290.5	310.7	331.7
Percentage Change	9.3	9.4	6.0	4.6	5.1	5.5	5.9	6.6	7.1	7.0	6.8
Yield of Triple A Bonds	11.9	14.2	13.8	11.1	10.4	10.3	10.4	10.4	10.4	10.1	9.8

Note: Historic values from Council of Economic Advisors Economic Report of the President, (Washington, D.C., 1983).

Date of Forecast Assumptions

The forecasts presented in this volume are based upon assumptions made in February 1983. Unanticipated events, new legislative enactments, or other major changes in the state of the world would clearly modify the assumptions and result in somewhat different forecasts.

Federal Regulation

It is the policy of the Energy Information Administration to base its projections on the statutes and regulations that exist at the time the projections are made. As a general rule, changes in programs that affect energy industries are not included in the forecasts until the changes have actually occurred. Thus, for example, the forecasts included in this volume are based on the assumption that the wellhead price controls on certain types of natural gas imposed by the Natural Gas Policy Act of 1978 (NGPA) will be removed according to the schedule contained in the Act, despite the large number of recent proposals and lengthy discussions concerning modification of the Act.

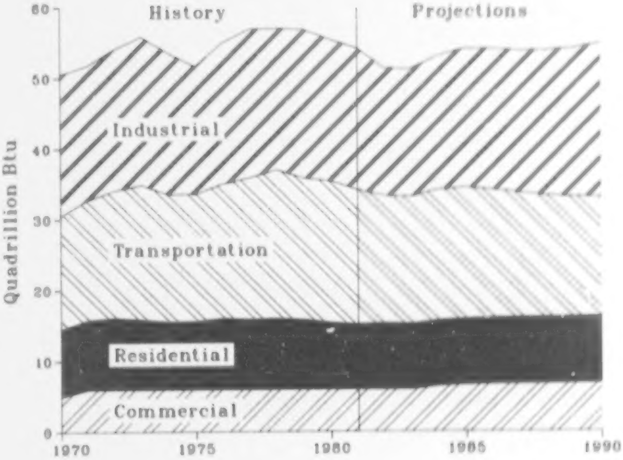
A similar approach is followed with respect to proposed changes in the Clean Air Act which would require retrofitting of existing powerplant to meet new emissions standards. The projections contained here assume that the current standards will be enforced. The projections would change in response to new requirements.

Two significant changes to the tax code are included in the projections presented in this chapter. The macroeconomic assumptions include the third of the reductions in personal income tax rates scheduled in the Economic Recovery Act of 1981, as well as the tax bracket indexation specified by that law. The effects of increased taxes on transportation fuel schedules to go into effect in April 1983 under the terms of the Surface Transportation Assistance Act of 1982 (P.L. 97-424) are also included.

End-Use Consumption

Energy consumption in the end-use sectors (residential, commercial, transportation, and industrial) is shown in Figure 10 and Appendix Table A.1.3. Dramatic changes in energy consumption occurred between 1973 and 1975 and after 1979, as large energy price increases led domestic consumers to use less energy. Because population has increased more

Figure 10. Energy Consumption by Industrial, Transportation, Residential, and Commercial Sectors, Midprice Scenario, 1970 to 1990 (Quadrillion Btu)



Source: Historical data: Energy Information Administration, State Energy Data Report, 1960 through 1980, DOE/EIA-0214(80) (Washington, D.C., 1982), and Monthly Energy Review, DOE/EIA-0035(83/2) (Washington, D.C., 1983).

rapidly than energy consumption since 1973, per capita use had declined by 14 percent by 1982. To some degree the recent decline in industrial activity contributed to the decrease.

Although energy use on a per capita basis is projected to continue to decline, total energy use is projected to rise modestly through 1990. In the early years, growth is based on economic recovery and relatively stable world oil prices; in the later years, modest growth in personal income, industrial activity, population, and diminished conservation activities contribute to the increase in total energy use.

The shares of total energy consumed by each sector are projected to change somewhat over the decade. In particular, the industrial sector is projected to account for a greater relative share of energy use, largely because energy inputs are used both as heat and power and as direct raw materials (e.g., petrochemical feedstocks) and because of the strong relationships between economic growth and industrial energy use.

Residential Demand

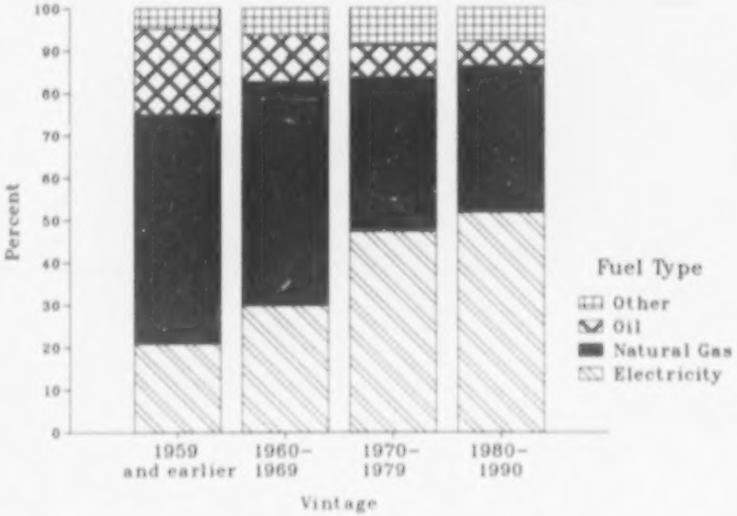
Patterns of residential energy consumption change slowly. These changes in energy consumption are largely determined by the long useful life of homes (much less than 1 percent of all homes are removed from use each year[1]) and the long lifetime of major heating equipment. Since most of the housing stock that will be present in 1990 already exists, that stock will generally reflect choices already made which were based upon prices and fuel availabilities at the time of construction (see Figure 11 and Appendix Table A.4.1).

The residential sector consisted of 80 million households in 1980 (up from 63 million in 1970).[2] These households occupied 55 million single unit structures, 21 million multi-unit structures, and 4 million mobile homes. The number of households is projected to increase to 95 million units in 1990. Of the 80 million occupied structures in 1980, 77 percent had been constructed before 1970. Of the 95 million occupied structures projected in 1990, 78 percent are projected to have been constructed before 1980.

Heating Uses. Fifty-four percent of 1980 residential energy consumption was for heating homes and 19 percent for heating water (a total of 73 percent).[3] The share of energy used for space heating is projected to decline to 49 percent by 1990 while that for water heating is projected to increase slightly to 20 percent (a total of 69 percent). The reasons for this change are varied: switching to more efficient heating fuels (using current technology); construction (and retrofitting) of more thermally efficient houses; installation of more efficient equipment; changes in energy consumption behavior such as turning back a thermostat; and continued migration of population to warmer regions requiring less space heating.

Natural gas is the major fuel consumed in the residential sector because it has been the fuel of choice for space heating. In 1980, residential natural gas consumption was 4.9 quadrillion Btu, which was 52 percent of total residential energy use. About 66 percent of all residential natural

Figure 11. Projected 1990 Residential Energy Consumption by Fuel and Vintage of Structure, Midprice Scenario (Percent vs. Vintage)



gas in 1980 was used for space heating and, in turn, 64 percent of all space heating was performed with natural gas. The choice of natural gas for space heating has been due to its low relative cost, ease of use, clean burning, and general availability (with some exceptions). An additional 22 percent of natural gas was used for water heating and, in turn, it accounted for 61 percent of water heating consumption.

Natural gas is projected to remain the major residential fuel consumed through 1990. By 1990 the level of natural gas consumption is projected to fall to 4.3 quadrillion Btu and its share is projected to decline to 47 percent (see Figure 12). There are several reasons for this decline. Natural gas, as the dominant fuel in space heating, declines in use more rapidly than other fuels since space heating declines in intensity of use. Natural gas use also declines because of an erosion in its price advantage. Although it remains the lowest priced fuel, its price is forecasted to increase from about 25 percent of the price of electricity in 1980 to about 46 percent in 1990 (see Figure 13). These price changes induce changes in consumer conservation behavior along with increased structure and equipment efficiency.

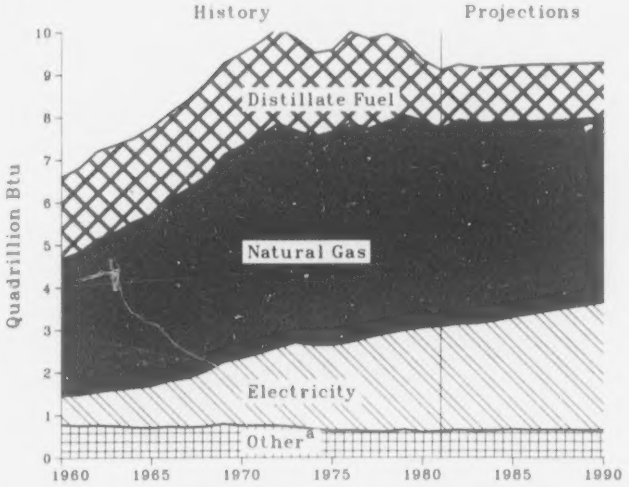
In 1980, residential oil consumption was 1.4 quadrillion Btu, or only 15 percent of total residential energy use. Oil was used largely for space heating in 1980 (83 percent of all oil use) but it was only 23 percent of space heating energy use. Oil consumption in the residential sector decreases slightly over the forecast period, declining to 1.3 quadrillion Btu in 1990 or 14 percent of residential consumption.

Other Uses. Twenty-seven percent of 1980 residential energy consumption was used for nonheating uses such as air conditioning, cooking, lighting, refrigeration, washing, drying, and various other primarily electricity-using services. The share of energy used for nonheating uses is projected to increase to 31 percent by 1990.

Electricity consumption is second to natural gas in the residential sector, despite its relatively unimportant role in space heating--only about 4 percent of residential space heating fuel consumption in 1980 was with electricity. In 1980, residential electricity consumption was 2.4 quadrillion Btu, or 26 percent of total residential energy use. The importance of electricity is due to its role in uses other than space heating and water heating, where alternative fuels often cannot easily be substituted. About 80 percent of all residential electricity in 1980 was used for nonheating uses and, in turn, about 77 percent of energy consumed for nonheating uses was performed with electricity.

Electricity consumption increases over the projection period to 3.0 quadrillion Btu in 1990, about 32 percent of residential energy consumption. This increase in electricity use is due to the dominance of electricity in the nonheating services, increasingly used in both new and existing housing. Also, since electricity is such a small part of space and water heating, widespread conservation in these uses has little impact on electricity consumption. (The share of electricity in space heating remains small--it is projected to increase from 4 percent in 1980 to about 7 percent in 1990.)

Figure 12. Residential Fuel Consumption, Midprice Scenario, 1960 to 1990 (Quadrillion Btu)

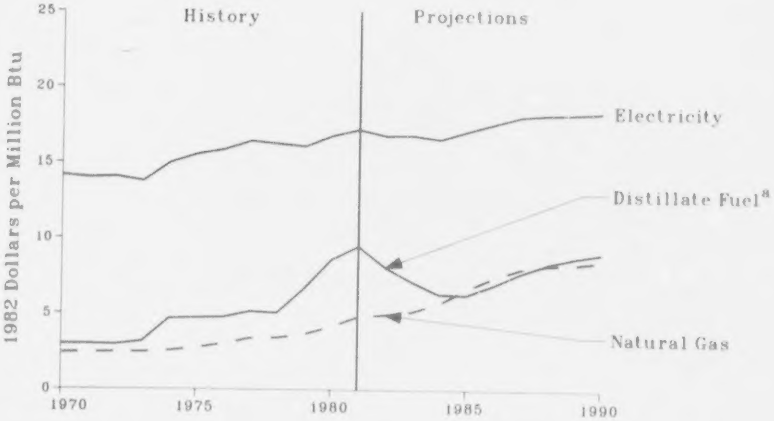


[a] Other includes liquid gas and coal consumption.

Note: Residential consumption of wood is not shown.

Source: Historical data: Energy Information Administration, State Energy Data Report, 1960 through 1980, DOE/EIA-0214(80) (Washington, D.C., 1982), and Estimates of U.S. Wood Energy Consumption from 1949 to 1981, DOE/EIA-0314 (Washington, D.C., 1982).

Figure 13. Average Residential Energy Prices, Midprice Scenario, 1970 to 1990 (1982 Dollars per Million Btu)



[a] Weighted average price of distillate fuel and kerosene.

Note: Weights used through 1980 are volumes of consumption as reported in Energy Information Administration, State Energy Data Report, 1960 through 1980, DOE/EIA-0214(80) (Washington, D.C., 1982).

Source: Historical data: Energy Information Administration, State Energy Price System, Volume 1: Overview and Technical Documentation, DOE/NBB-0029(1/2) (Washington, D.C., 1982).

Wood Consumption

Since most wood is not a marketed fuel with a meaningful price, wood is not included in the residential consumption totals and averages discussed. Wood energy consumption in the residential sector has dramatically increased in the last few years. Wood has been used increasingly to supplement and, in some cases, to substitute for other fuels in space heating, due to the rapid increase in prices of conventional fuels. Wood consumption had been declining steadily until 1973 when it was 0.3 quadrillion Btu. Since 1973 its consumption has increased to 0.8 quadrillion Btu in 1980.[6] Wood consumption is projected to increase to 1.2 quadrillion Btu in 1990.

Overall Use. The average household in 1980 consumed 117 million Btu of energy in all activities. This average energy use has declined in each year since 1976 when it was 136 million Btu per household.[4] Increases in average energy use in earlier periods were due to larger average house size, falling or steady real fuel prices, and increased use of various energy consuming services in the household. The average energy use per household is projected to fall to 98 million Btu per household in 1990 for an average annual decrease (from 1980) of 1.8 percent. The reasons for this decrease are varied, but the overriding cause is the substantial increase in real energy prices over the projection period. Residential fuel prices are projected to increase from an average of $8.33 in 1980 to $11.74 in 1990 (in 1982 dollars per million Btu), for an average annual increase of 3.5 percent. These price increases induce changes which include more efficient houses, more efficient equipment, and household conservation.

Regional differences can have a strong impact on residential energy use. Some major regional effects on residential energy use include generally higher prices in the Northeast, migration of populations to the Southwest, and greater average space heating loads in the Northeast. In 1980, the average energy use for all residential uses was 128 million Btu per household in the Northeast Census region, 154 million Btu in North Central, 95 million Btu in the South, and 90 million Btu in the West.

Commercial Energy Demand

Like the residential sector, 1990 energy use by the commercial sector will be largely determined by the stock of buildings already in existence. These buildings will account for roughly 70 percent of commercial energy use in 1990. Commercial energy consumption has grown more rapidly than that of any other sector and reflects the trend toward the increasing service orientation of the economy. Total energy use is projected to

New Technologies in Residential and Commercial Buildings

The equipment used to convert energy into various services constantly undergoes substantial improvement. In recent years, however, these "new technologies" have been emerging rapidly and usually with a particular purpose: to increase efficiency in energy use. The major driving force behind emerging technologies over the last several years (and into the future) has been rapidly increasing real energy prices. In many cases, the introduction of these new technologies leads to dramatic energy savings.

In the residential sector, there are a large number of continuing innovations, but those centering around space heating entertain the most potential for fuel conservation. The electric heat pump has been an established technology for several years and was installed in 24 percent of all newly constructed single-family homes in 1980. This technology can provide substantial savings over conventional resistance electric heating in moderate climates (savings on the order of 25 to 50 percent). The future promises even more significant advance on this technology with "water-to-air" transfer heat pumps, advanced heat pumps (such as variable-speed heat pumps with a potential for 15 to 25 percent further energy savings), and thermally activated heat pumps using natural gas (up to 40 percent energy savings). Recently entering the residential market have been pulse combustion furnaces for oil and natural gas. These natural gas furnaces claim conversion efficiency ratings of 90 to 95 percent (compared to a 60 to 65 percent efficiency for a conventional furnace). Another technology for gas furnaces, claiming similar efficiencies, extracts exhaust heat for space heating. These furnaces have substantially higher capital costs, but should provide significant savings on operating costs.

In the commercial sector, the range of new technologies available depends on building size. In small commercial establishments, which are the majority of commercial buildings, the relevant new technologies will be similar to those available to the residential sector. For larger commercial buildings, such as offices, shopping malls, and institutions, energy management systems and cogeneration are alternatives that can reduce energy consumption and improve efficiency. Energy management systems already enjoy wide use among larger establishments. With these systems, automated mechanisms direct energy services to the various users in large buildings in efficient patterns. Cogeneration is an attractive alternative for buildings that use steam for space heating. In this process, what would normally be waste heat is used to provide further energy services. While cogeneration can achieve substantial energy savings, its penetration will likely be limited because of its highly capital-intensive nature.

increase by nearly 17 percent from 1980 to 1990. During the same period, energy use per square foot is expected to decline while electricity replaces natural gas as the primary fuel. These and other trends in energy use can be seen in Figure 14 and Appendix Table A.4.2.

By 1990, commercial energy demand is forecast to reach 6.9 quadrillion Btu, an average annual rate of increase of 1.5 percent throughout the 1980's. Over the same period, the real prices of the major fuels used by this sector increase steadily. However, the continuing growth of commercial floorspace at 2.6 percent annually overcomes what would otherwise be a trend of decreasing total energy use.

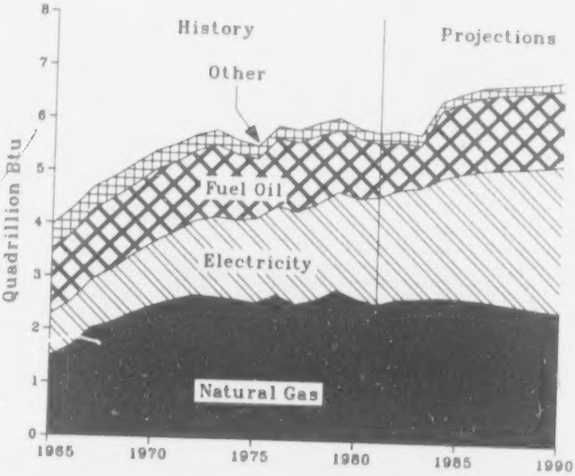
Electricity consumption is forecast to increase from 1.9 quadrillion Btu in 1980 to 2.8 quadrillion Btu in 1990. This robust growth in electricity usage can be attributed to several factors, some of which have parallels in the residential sector.

An important reason for the strong performance of electricity has to do with the projected growth of floorspace by type of building. Over the next decade, roughly 70 percent of all floorspace growth is forecast to occur in the office and retail/wholesale categories. The historical importance of these two categories is witnessed by Figure 15, which shows that they accounted for 60 percent of total energy demand in 1979. These categories were also relatively intensive users of electricity in 1979, as illustrated in Figure 16, and this leads to increasing utilization of electricity for the entire commercial sector. Other reasons for electricity's rapid growth include:

- Most floorspace growth is concentrated in the South and West Census Regions which rely heavily on electricity.
- Natural gas and fuel oil are used mainly for space heating, which accounts for a declining proportion of energy use.
- New end uses for electricity will continue to be developed.
- Electricity prices are projected to increase less rapidly than the prices of other fuels, although they remain higher.

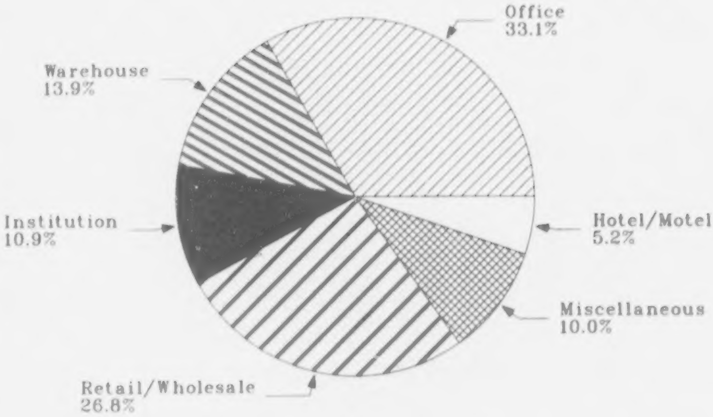
From 1960 to 1972 commercial natural gas consumption increased steadily. During the 1960's, it grew at an average annual rate of nearly 9 percent a year. However, in the 1970's, this rate dropped to .8 percent annually and consumption no longer grew steadily. From 1973 to 1980, natural gas consumption fluctuated with the general level of economic activity. During the 1980's, natural gas consumption is forecast to decline slightly. While this decline represents a reversal of the past growth trend, it occurs during a period when commercial natural gas prices are projected to rise in excess of 8 percent annually. The price of natural gas increases substantially relative to both electricity and fuel oil, decreasing use. Finally, distillate and residual fuel oil usage is

Figure 14. Total Commercial Energy Use By Fuel, Midprice Scenario, 1965 to 1990 (Quadrillion Btu)



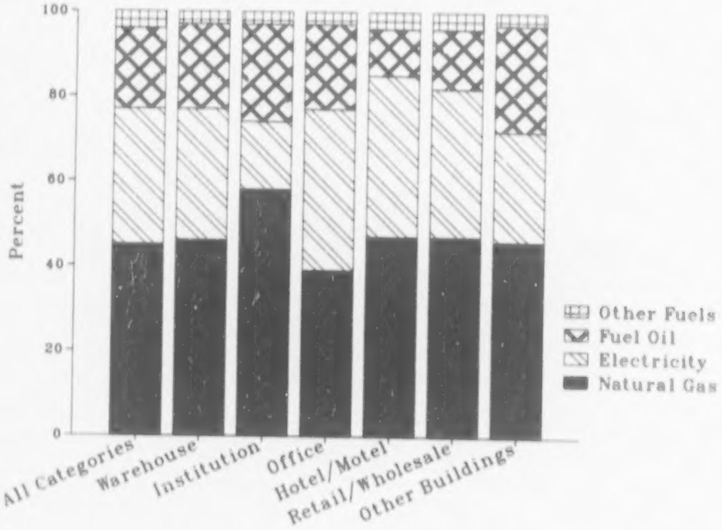
Source: Historical data: Energy Information Administration, State Energy Data Report, 1960 through 1980, DOE/EIA-0214(80) (Washington, D.C., 1982), and Monthly Energy Review, DOE/EIA-0035(83/2) (Washington, D.C., 1983).

Figure 15. Percentage of Total Energy Consumed by Nonresidential Building Category in 1979 (Percent)



Source: Historical data: Estimated by the Energy Information Administration, from a computer tape of disaggregated data underlying its publication Nonresidential Buildings Energy Consumption Survey: Fuel Characteristics and Conservation Practices, DOE/EIA-0278 (Washington, D.C., 1981).

Figure 16. Percentage of Energy Consumption by Fuel and Nonresidential Building Category in 1979 (Percent)



Source: Historical data: Estimated by the Energy Information Administration, from a computer tape of disaggregated data underlying its publication Nonresidential Buildings Energy Consumption Survey: Fuel Characteristics and Conservation Practices, DOE/EIA-0278 (Washington, D.C., 1981).

forecast to increase throughout the 1980's. In 1980, demand for fuel oil was 1.1 quadrillion Btu. By 1990, it is projected to rise to 1.4 quadrillion Btu. The real price of fuel oil increases at only 0.4 percent annually during the 1980's. Increased efficiency results in a 0.1 percent decline in fuel oil consumption per square foot over the projection period. This effect is mitigated by continuing floorspace growth resulting in an increasing level of fuel oil use over the decade.

Industrial Demand

The industrial sector[7] is the largest end-use consumer of energy in the economy, using fuels both for heat and power and as a raw material. In 1980, this sector accounted for 35 percent of the energy consumed in the United States by end-use sectors.

Energy plays a more important role with some classes of manufacturers than with others, and both the cost incentives and the potential for energy savings vary accordingly. Many industrial plants were able to obtain substantial increases in energy efficiency (measured by the decrease in the amount of purchased energy per unit of output) quickly and at relatively low cost by such devices as employee energy awareness programs, control of plant lighting and heating, equipment insulation, and improved maintenance of steam systems. Much of the early increase in energy efficiency after the 1974 to 1975 price rise can be attributed to such programs.

The ability of the manufacturing industries to offset future fuel price rises by additional reductions in energy consumption depends, at least in part, upon the technical sophistication of the industry and upon the availability and cost of capital for equipment replacement and upgrading. Further decreases in a plant's energy use, after initial conservation efforts, usually entail some modification of the capital equipment, such as reconfiguration of kilns and ovens or installation of more efficient boilers and heat recovery systems. Although such changes can be effective in reducing energy costs, their implementation is in competition with other plant needs for the required capital. Thus, actions to upgrade energy efficiency are sometimes deferred until the occurrence of other capital expenditures or await the scheduled replacement of an obsolescent process unit with a more energy efficient one. That such a delayed response to energy cost can be significant is shown by analysis of the industrial energy efficiency data reported by corporations in compliance with the National Energy Conservation Policy Act.[8] It was observed that those manufacturing industries that exhibited a comparatively high increase in energy efficiency during the 1972 to 1979 interval tended also be those industries with a comparatively high post-1973 change in capital stock.

The bulk of manufacturers' energy consumption is concentrated in five broad groups of manufacturers: Chemicals and Allied Products (Standard Industrial Code (SIC) 28); Primary Metal Industries (SIC 33); Paper and Allied Products (SIC 26); Stone, Clay, and Glass Products (SIC 32); and

Food and Kindred Products (SIC 20). In 1980, manufacturers in these five SIC groups consume about 65 percent of total industrial purchased energy for heat and power and essentially all fuels used as raw materials. Consumption for these uses is shown in Figure 17.

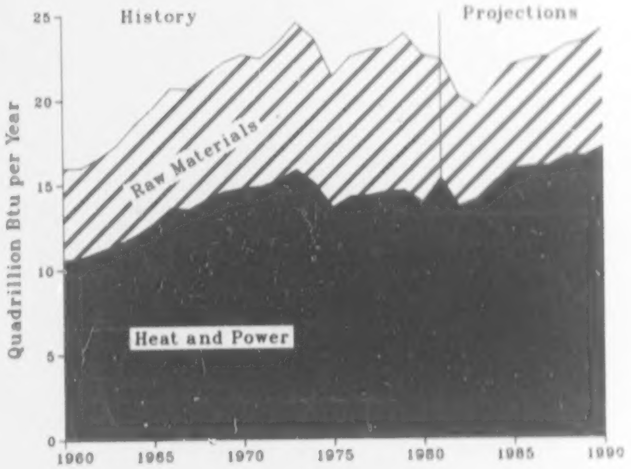
The major industrial energy consumers differed considerably in their ability to reduce energy consumption after the fuel shortages and price shocks of the mid-1970's. Two of these groups (Chemicals and Paper) were comparatively successful in reducing the amounts of purchased energy needed to manufacture their products. The chemical industry (characterized by relatively high investment rates, rapid equipment replacement, and plant turnover) experienced frequent opportunities to upgrade process equipment and retrofit plants. By 1979, the required number of Btu of purchased energy per unit of output was less than 80 percent of the energy requirement of 1972. The paper industry reduced its purchased fuel needs by a comparable percentage, but in the case of this industry a major part of the reduction was accomplished by a trend toward greater use of byproduct and nonpurchased fuels. This trend began before the oil price shocks of the 1970's. The energy obtained by the paper industry from consumption of waste wood, bark, and pulping liquor grew from 41 percent of total energy use in 1972 to 45 percent in 1976 and 48 percent in 1980. In 1979 and 1980, the chemical industry's consumption of nonpurchased fuels, in thermal units, has averaged 23 percent of purchased fuels for heat and power.[9]

The iron and steel industry (SIC-331) provides a contrast to the above. This industry's long-standing difficulties in maintaining profitability and capacity utilization have reduced the availability of capital for replacement of inefficient production equipment. As a result of the low-asset turnover rate, the existing equipment tends to be old and comparatively energy inefficient. Most large energy conservation opportunities in the iron and steel industry involve capital-intensive modernization of facilities (for example, replacement of open hearth furnaces and use of continuous casting), and, until the industry's capital-formation problems are resolved, increases in energy efficiency can be expected to remain modest.

The choice of fuel has responded very strongly to relative prices. Since 1974, natural gas has replaced much of the oil used both in boilers and in other process heat applications. Although much of this change was due to a continuation of long-term trends, shifts in the relative prices of oil and gas had a large effect on their relative market shares. Electricity, like gas, continued to increase its market share throughout the seventies; most of this increase was due to long-term technological trends.

Although the late 1970's witnessed the leveling off of a long historical decline in manufacturers' use of coal for heat and power (from 129 million tons in 1951 to 61 million tons in 1977), coal has shown relatively little penetration of the industrial uses now dominated by oil and gas. One reason for the failure of coal to increase its share of manufacturing energy has been the sluggish performance of the iron and steel industry, one of the major consumers of coal for heat and power uses. Projections

Figure 17. Industrial Energy Consumption by End Use, Midprice Scenario, 1960 to 1990 (Quadrillion Btu)



Note: Heat and Power includes refinery fuel use. Raw Materials includes natural gas feedstocks, petrochemical feedstocks, oil raw materials, and metallurgical coal.

Source: Historical data: Energy Information Administration, 1981 Annual Report to Congress, Volume 2, DOE/EIA-0173(81)/2 (Washington, D.C., 1982), Coke and Coal Chemicals in 1980, DOE/EIA-0120(80) (Washington, D.C., 1981), Crude Petroleum, Petroleum Products, and Natural Gas Liquids: 1980 Final Summary, DOE/EIA-0108(80) (Washington, D.C., 1981), and Petroleum Supply Monthly, DOE/EIA-0109(82/3 to 83/2) (Washington D.C., 1982 and 1983).

of future industrial coal demand, then, will depend on the health of this key industry. In general, the rate of coal use has been less than expected on the basis of its price advantage over oil and natural gas.

Projections. Figure 18 and Appendix Table A.4.3 show the midprice projections for the consumption of various fuels through 1990 in the industrial sector. Total energy consumption grows at .7 percent per year, largely because of recovery and economic growth. Electricity use grows at a rate of 3.2 percent annually. Total coal use increases at a rate of approximately 1.3 percent annually, due to offsetting trends in heat and power use and coking coal use.

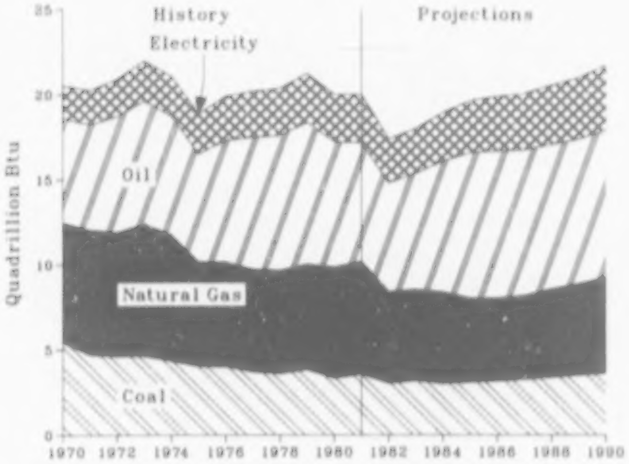
The large projected increases in gas prices lead to shifts in consumption from gas to oil. However, when oil prices increase in the late 1980's, the share of gas increases. Coal (in heat and power uses) grows more rapidly than any other fuel, because it remains cheaper than oil and gas as a fuel for boilers. In these applications, coal grows at an average annual rate of 5.0 percent a year. The projected decline in coking coal use, approximately 2.6 percent a year, reflects technological trends in steel making, increased use of electric arc furnaces, continuous casting, and a projected slower rate of steel output growth (reflecting lighter weight steel and increased competition from other products). Petrochemical feedstocks are projected to increase at a rate of 1.7 percent a year due to the availability of cheaper feedstocks overseas, but output mix changes resulting from a projected shift from bulk to speciality chemicals may also play a role.[18]

Growth in Electricity Demand in the Industrial Sector. The forecast of growth in industrial electricity used in the midprice case reflects both a recovery of the economy and a positive trend in industrial consumption of electric power. As the economic recovery proceeds, manufacturing activity is projected to expand more rapidly than the general economy, increasing the rate of consumption of inputs into the industrial sector. In addition, because heavy industrial electricity uses have encountered disproportionally large declines in output levels as a result of the recession, growth in electricity consumption during the recovery is high.

The trend toward increased electrification of industrial processes has been observed over many years. The rate at which electricity can be economically substituted for other energy sources in industrial processes changes with both technology and relative energy prices. In this forecast, this trend is assumed to replicate the experience of the economy during the 1963 to 1973 interval, a period of similar expansion of industrial activity. As a result of this combination of forces, growth in industrial electricity consumption exceeds the projected growth in the overall economy.

Sources of Uncertainty. Economic growth, productivity growth, and the availability of capital through 1990 are central to these projections and are uncertain. Imports are also a major source of uncertainty. If the U.S. imports more steel, metal products, and petrochemicals, domestic energy consumption in these industries will grow more slowly.

Figure 18. Industrial Energy Use[a] by Fuel, Midprice Scenario, 1970 to 1990 (Quadrillion Btu)



[a]Excludes refinery fuel use.

Source: Historical data: Energy Information Administration, State Energy Data Report, 1960 through 1980, DOE/EIA-0214(80) (Washington, D.C., 1982), and Monthly Energy Review, DOE/EIA-0035(83/2) (Washington, D.C., 1983).

Historical energy consumption trends, which furnish the basis for the projections of future consumption, might also be changed by technical innovation or by accelerated reconfiguration of equipment in response to foreign competition. Thus, for example, the introduction into iron and steel production of the direct "coal reduction" technology (which permits replacement of metallurgical coal by relatively inexpensive steam coal) might shift energy consumption from electric furnaces towards coal.[11]

There is substantial uncertainty about the amount of electricity needed to power the U.S. industrial sector throughout the projection period. This uncertainty stems from two different causes. First, cycles in the overall level of economic activity make it difficult to predict accurately which industrial activities will experience the most growth through 1990. Each type of activity uses a particular mix of energy and energy intensity levels also differ across industries. Changes in the growth of individual industrial activities will change the overall demand for energy and electricity.

The second cause of uncertainty in the industrial electricity demand projections can be characterized as uncertainty with respect to the availability and rate of implementation of energy conservation measures by industrial concerns. Because trend variables are used in forecasting to capture these changes, an alternative specification of the rate at which they can be expected to occur was developed to show the implications of variations in these trends for industrial energy consumption. A "Low Industrial Electricity Demand" sensitivity case shows industrial electricity consumption may be as much as 300 trillion Btu's lower in 1990. This would imply an alternative rate of growth in electricity of 4.2 percent between 1982 and 1990. The full results of this and other sensitivity analyses may be found in the Appendix.

Transportation Demand

In the transportation sector, greater energy efficiency is being built into the capital stock as more fuel-efficient cars, trucks, and aircraft join the national fleets and replace older equipment. A rapid increase in average fleet efficiency is expected through 1990 over a wide range of fuel prices. A number of factors (current and past high fuel prices, legislated design standards, general technical progress, manufacturers' production plans, and consumer taste changes) have resulted in a situation that almost guarantees that new-vehicle fuel efficiency will continue to surpass fleet fuel efficiency. Consequently, total transportation fuel use is projected to decline by 1.5 percent annually between 1980 and 1990.

Light Vehicles. Automobiles and light-duty trucks (less than 8,500 lbs. gross vehicle weight) offer the most dramatic example of the momentum toward increased fuel efficiency. Projected new-vehicle miles per gallon (mpg) in each year is considerably above the projected fleet average in the same years, thus promoting higher fleet fuel efficiency through the forecast period. Even if manufacturer average mpg performance should fall below the mandated legislative standard in any given year or even below the performance of the previous year, mpg will almost certainly exceed the mpg of scrapped units by a wide margin. Higher fuel prices would be expected to induce some increase in fleet mpg should they occur, but this induced increase is small compared to the trend projected to push fleet mpg up about 5.1 percent anually over the 1983 to 1990 period.

Total fuel consumed by light vehicles (or any class of vehicles) can be factored into vehicle-miles traveled times average gallons per mile (the reciprocal of average mpg). Vehicle-miles traveled are forecasted to rise, along with the economy, by 2.3 percent annually from 1980 to 1990 (midprice scenario). If average fleet fuel efficiency remains constant, total fuel consumption would increase by the same percentage. In fact, light-vehicle fuel consumption is projected to decline from 98.6 to 79.5 million gallons. The effects of increased fuel efficiency are larger than the effects of increased driving induced by increased economic activity.

The major sources of increased fleet fuel efficiency in the period up to 1990 will be the familiar ones that have increased new-car fuel economy in the recent past: improved engine efficiency, reduced vehicle weight, downsizing, lowered average vehicle power, and diesel engine use. As the fleet turns over during the 1980's, these features will progressively be incorporated in the fleet. Fleet average mpg, however, is not projected to reach the 1982 new-vehicle average mpg until 1989 under the midprice scenario.

New-car mpg is projected to improve over the period due to continued improvements currently incorporated in manufacturers' production plans. Depending somewhat on consumer response, these plans will govern auto technology through 1987. In the 1988 to 1990 period, electronic combustion control and the use of advanced light-weight materials in major vehicle components are likely to become economic for manufacturers to introduce into large-scale production. Rapid introduction of diesel vehicles in the fleet is not projected, nor are turbochargers expected to be a major feature of moderately priced diesel vehicles in the pre-1990 period.

It is always possible that manufacturers may cancel previously programmed new initiatives. A number of such cancellations have been announced in recent months. However, the reverse action is not possible. Manufacturers are not generally able to develop major new production plans, however, without a lead time of 4 or 5 years.

Heavy Trucks. Projected heavy truck fuel consumption parallels the light vehicles' fuel use. An increase in fuel efficiency (arising in part from increased diesel engine use) of 3.5 percent annually is projected from 1982 to 1990. Variations in the amount of driving, in turn dependent upon the demand for goods transportation, is a substantial factor also. The demand for transportation services is projected to grow with the level of economic activity through the 1980's. Heavy truck fuel consumption is projected to remain nearly constant through 1990.

Aircraft. In the airline industry, average fuel consumption per passenger-mile is affected not only by technical aircraft efficiency but by the economic choices airlines make about flight frequency, load factor, seating density, and relative utilization rates of different-size aircraft. Even fleet composition can be altered rapidly due to an active international secondary market in aircraft and due to the rapid expansion of the industry in all but recession periods.

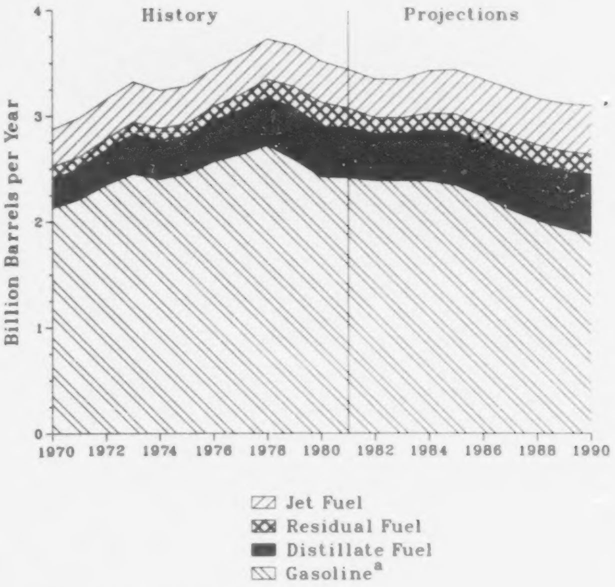
The experience of the 1970's illustrates the complexity of airline fuel economics. Airlines reduced fuel consumption per passenger-mile so rapidly in response to higher fuel prices that jet fuel consumption was no higher in 1980 than in 1973 despite an increase in activity (revenue passenger-miles) of 57 percent over the period.[12] Unlike highway transport, however, the airlines achieved this primarily by increasing operating efficiency, that is, by increasing load factor, seating density, and average flight size. They were able to do so by altering flight scheduling, aircraft assignment, and fleet mix. A Department of Energy study estimates that technical efficiency improvements (including aircraft design, taxiing practices, and angle of descent) were responsible for only 15 percent of fuel-efficiency improvement in the 1973 to 1980 period.[13]

The 1990 forecast is for substantial increase in airline activity (revenue passenger-miles increase by 4.6 percent annually percent from 1980) and for further increases in load factor and average flight size. Consequently, jet fuel consumption increases at an average annual rate of 2.4 percent from 1980 to 1990.

Total Transportation Fuel Consumption. Figure 19 and Appendix Table A.4.4 present the forecasts of total transportation fuel consumption for the midprice case. Total gasoline consumption, primarily used in light vehicles, is forecast to decline by 22 percent from 1982 to 1990. At the same time, increased economic activity and growth in the stock of diesel cars and trucks lead to a 3.2 percent average annual rate of increase in diesel fuel.

Residual fuel oil, primarily used in marine transportation (i.e., as ships bunker fuel), also increases because of the general growth of the economy over time, hence increased demand for transportation services. Between 1982 and 1990, transportation fuel demand declines at an average annual rate of .8 percent.

Figure 19. Transportation Petroleum Use, Midprice Scenario, 1970 to 1990 (Billion Barrels per Year)



[a] Motor and aviation gasoline.

Note: Transportation use of liquified petroleum gases does not exceed 0.01 billion barrels per year and is not shown in the figure.

Source: Historical data: Energy Information Administration, State Energy Data Report, 1960 through 1980, DOE/EIA-0214(80) (Washington, D.C., 1982), and Monthly Energy Review, DOE/EIA-0035(83/2) (Washington, D.C., 1983).

Electric Utilities

Electricity demand in the United States has grown slowly since the oil embargo in 1973. Since 1979, the annual growth rate has remained below 2 percent[14] and has declined steadily, whereas the pre-embargo growth rate averaged about 7 percent per year.[15] During 1982, domestic electricity demand actually declined by about 3 percent, resulting in the first absolute decrease in generation since 1945.

The current decline in domestic electricity generation resulted from a decrease in industrial electricity demand that was significant enough to lower overall electricity consumption despite slight increases in residential and commercial usage (see Figure 20). The overall departure from the pre-embargo demand growth is due, in large part, to rising fossil fuel prices. Since 1973, the prices of coal, residual fuel oil, and natural gas delivered to steam plants have more than doubled, tripled, and quadrupled, respectively.[16] On a Btu-equivalent basis, the price of coal in 1982 was about one-third the price of residual oil and one-half the price of natural gas.

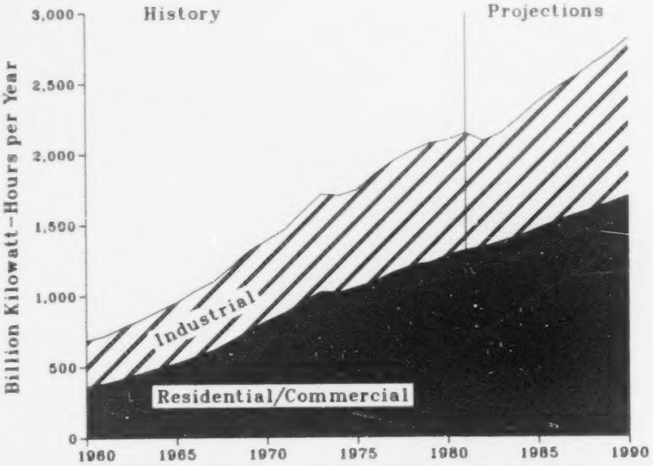
In the midprice case, electricity demand is projected to grow at an average annual rate of about 3 percent between 1980 and 1990. Based on this growth rate, the incremental demand would exceed the expected production from planned capacity additions, which consist primarily of coal and nuclear plants and total 171 gigawatts between January 1, 1980, and January 1, 1990.

Earlier EIA forecasts contained more optimistic estimates of new powerplant construction. For instance, EIA's 1981 Annual Report to Congress included 187 gigawatts of new capacity during the 1980's.[17] However, many scheduled plants have been postponed or cancelled in recent years because of lower-than-anticipated electricity demand, which reduced the immediate need for additional capacity, and higher capital costs, which increased the cost of financing construction. This has a considerable effect on utility fuel consumption, particularly oil and natural gas. The impacts of low demand growth and utility financial difficulties on fuel consumption will be discussed in greater detail below.

Electric Utility Production and Fuel Consumption

In the midprice case, nuclear and coal-fired powerplants are projected to be the most prominent sources of domestic electricity supply (see Figure 21). Nuclear plants are projected to generate 19 percent of the total electricity by 1990, compared to 13 percent in 1982.[18] Consequently, fuel inputs to nuclear plants approximately double during the forecast period. Coal-fired generation is projected to account for 51 percent of total electricity generation by 1990, compared to 53 percent in 1982.[19] Although utility coal consumption is projected to rise by about 29 percent between 1982 and 1990 as new coal plants are completed and begin operation, the slight decline in the percentage of total electricity generation occurs because the absolute growth in total generation is greater than the absolute growth in coal-fired electricity generation.

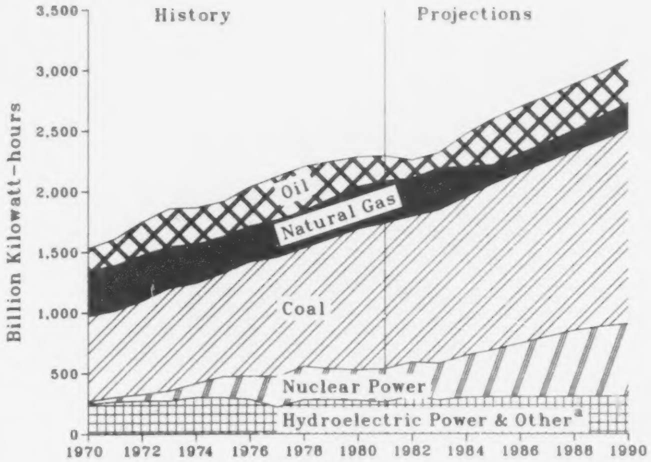
Figure 20. Electricity Consumption by End Use, Midprice Scenario, 1960 to 1990 (Billion Kilowatt-Hours per Year)



Note: Transportation use of electricity does not exceed 3 billion kilowatt-hours per year and is not shown in the figure.

Source: Historical data: Energy Information Administration, State Energy Data Report, 1960 through 1980, DOE/EIA-0214(80) (Washington, D.C., 1982), and Monthly Energy Review, DOE/EIA-0035(83/2) (Washington, D.C., 1983).

Figure 21. Sources of U.S. Electrical Supply, Midprice Scenario, 1970 to 1990 (Billion Kilowatt-Hours)



[a]Other includes geothermal, wood, waste, and net imports of electricity.

Source: Historical data: Energy Information Administration, 1981 Annual Report to Congress, Volume 2, DOE/EIA-0173(81)/2 (Washington, D.C., 1982), and Monthly Energy Review, DOE/EIA-0035(83/2) (Washington, D.C., 1983).

However, the projected reliance on coal and nuclear capacity is not as great as might be expected, given the relative fuel prices, because fuel consumption is limited by the available mix of generating capacity. Although abundant supplies of coal and uranium exist, construction and licensing periods for coal and nuclear plants are lengthy. Only coal and nuclear plants that are already under construction will be available to meet demand growth or replace existing oil and gas capacity by 1990.

Fluctuations in the relative prices of oil and gas have little impact on their combined use by electric utilities since they represent the marginal fuel choices. However, the relative prices play a significant role in the actual oil/gas split since many plants have the flexibility to burn either fuel. In the 1990 midprice forecast, utility oil and natural gas consumption is projected to total 6.4 quadrillion Btu, an increase of 31 percent from 1982. However, oil is projected to account for 63 percent of the total oil and gas demand in 1990, compared to just 32 percent in 1982. Using the 1990 midprice forecast as a reference point, total utility oil and gas demand decreases by just 3 percent in the high oil price case, but oil consumption declines by 29 percent while natural gas use rises by 41 percent. In the low oil price case, total oil and gas consumption increases by 4 percent. Oil consumption increases by 23 percent while natural gas use decreases by 27 percent. Thus, an escalation of gas prices coupled with lower oil prices would likely produce considerable switching from natural gas to oil. In the middle world oil price case this happens in 1984-1985. The switching of utilities from gas to oil in turn moderates the increase in natural gas prices.

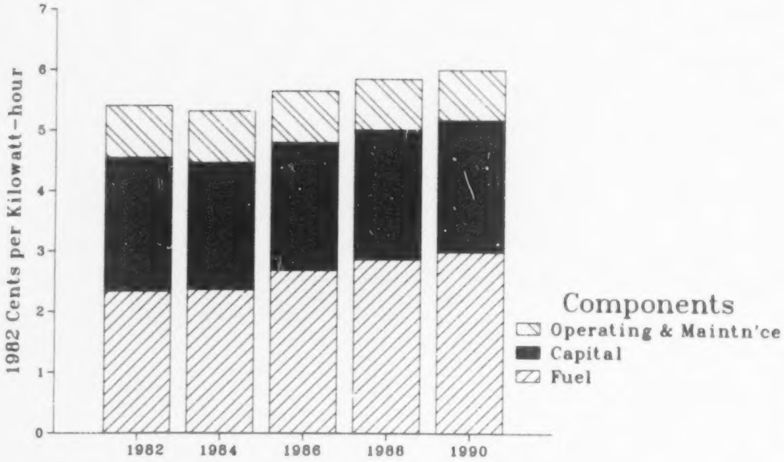
Besides the relative prices of the potential input fuels, other factors will play a significant role in the degree of fuel switching that occurs during the forecast horizon. Existing contracts could "lock" a utility into using a particular fossil fuel. Also, the difficulty and expense of switching differs from plant to plant depending on the availability and cost of the secondary fuel.

Due to the uncertainty associated with the "dual-fired" capability, an alternative case limiting fuel switches was also considered. Compared to the midprice case, this would result in a 17 percent increase in utility natural gas use and 10 percent decrease in oil consumption in 1990. This case is discussed in greater detail in the Appendix.

Financing Utility Construction

The electric utilities industry is highly capital-intensive; capital-related charges typically account for about 30 to 40 percent of the price of electricity. Throughout the forecast period, the capital cost component is projected to account for 35 to 40 percent of the electricity price (see Figure 22 and Appendix Table A.5.5). Due to long construction periods, utilities must base their construction schedules on future demand expectations. Until the early 1970's, this proved to be a relatively simple task, as output prices fell and electricity consumption grew at a fairly steady and predictable rate. However, demand forecasting became increasingly difficult as consumers began instituting conservation measures and substituting alternative energy sources in response to rapidly rising electricity prices.

Figure 22. Projected Average Electricity Prices and Cost Components, Midprice Scenario, Selected Years (1982 Cents per Kilowatt-Hour)



Note: All data are Intermediate Future Forecasting System projections, including 1982 data.

In the late 1970's, the cash flow position of many utilities began to deteriorate as generation costs rose rapidly and revenues decreased with declining electricity demand growth rates. Financial pressures were further compounded by inflation and a general weakening of the economy. As the cost of capital continued to rise, many utilities found their debt-equity ratios raised to increasingly uncomfortable levels and began to reevaluate their construction schedules.

During 1981 and 1982, the financial condition of electric utilities improved as a result of declining inflation rates, quicker responses by regulatory agencies, new Federal tax incentives, and moderated capital expenditures. In many States, the public utility commissions (PUC's) have helped to alleviate utility financial stress by allowing higher rates of return and reassessing their treatment of construction work in progress (CWIP). This has improved the immediate cash flow of many utilities and increased the funds available for internal financing. Growth in electricity demand would further strengthen the cash flow of utilities by increasing revenues. The prospect of increased cash flow has begun to lead to higher stock prices, thereby improving the capital market attractiveness of utilities.

Coal Usage and Environmental Regulations

Utility consumption of coal is projected to increase from 12.7 quadrillion Btu to 16.3 quadrillion Btu between 1981 and 1990 because projected coal prices rise relatively slowly compared to other fossil fuels burned by electric utilities.[20] Projections indicate a gradual shift from "high-" sulfur coals to "medium-" and "low-" sulfur coals over the forecast horizon. Utility consumption of high-sulfur coal, which represented about 37 percent of the utility coal demand in 1981 is projected to decline to 36 percent in 1985 and 35 percent in 1990. Consequently, utilities use more coal produced in the West, the primary source of low- and medium-sulfur subbituminous coal and lignite.

This trend toward low-sulfur coal primarily results from the New Source Performance Standards (NSPS), which place emissions restrictions on "new" coal-fired plants currently under construction which were licensed before September 1978. Utilities can generally satisfy the NSPS by burning low-sulfur coal without using sulfur emission control equipment. As more of the plants subject to the NSPS begin to operate throughout the forecast horizon, the demand for low-sulfur coal will increase.

Plants currently under construction that obtained a license after September 1978 are subject to the Revised New Source Performance Standards (RNSPS). The RNSPS tend to increase the attractiveness of high-sulfur coal since they require all coal-fired plants to build flue gas desulfurization equipment, although less scrubbing capacity is needed for low-sulfur coal. However, the standards have relatively little impact within the time frame of this forecast because many plants subject to the RNSPS do not begin operation before 1990 due to long construction lead times and delays.

Clean Air Act

The Senate Committee on Environment and Public Works proposed bill S.3041, Clean Air Act Amendment of 1982, amends Section 120 of the Act by adding a new "Part E" to address the problem of acid deposition in the eastern United States. Part E establishes an acid deposition impact region consisting of 31 States and the District of Columbia: the 26 States east of the Mississippi River and 5 States contiguous to it on the west.

This part of the Act requires by January 1, 1995, a reduction in annual emissions of sulfur dioxide of 8 million tons from the actual emissions level in 1980. The Office of Technology Assessment estimates the 1980 annual emissions level of sulfur dioxide at 16,067,700 tons.[23] Increases in sulfur dioxide emissions from major stationary sources that take place after January 1, 1981, must be offset by reductions elsewhere in the region by 1995. There are two exceptions to this requirement. These are increases up to 1.5 pounds per million Btu resulting from conversion to coal of utility boilers and increases that take place in a State that during 1980 had no utility boiler with an actual annual sulfur dioxide emission rate greater than 1.2 pounds per million Btu.

Any major stationary source of sulfur dioxide that starts operation after January 1, 1995, must provide for simultaneous reductions in emissions elsewhere in the region to offset its emissions unless it adopts best available control technology and meets the most stringent emission limitation achieved by any source of the same size, type, and class in the acid deposition region. Emissions of nitrogen oxides from existing major stationary sources, except for coal conversions, may not increase over 1980 levels or levels experienced during a 30-day period immediately prior to enactment, unless equivalent reductions are obtained in the region.

Other Sources of Uncertainty

In addition to financial and environmental questions, there are several other areas of uncertainty about the future outlook of the electric utilities industry. One important variable which could have a measurable impact on the electric utilities industry is the time patterns of demand. Since electricity cannot be stored (except for pumped storage generation) it must be produced upon demand; thus, it is the timing of the demands as well as the total volume that determines the capacity and generation requirements. Shifting some demand from peak to off-peak periods would increase the base (continuous) load and lead to improved capacity utilization. It would likely reduce fuel inputs since the boiler would operate continuously, thereby eliminating the energy loss that occurs during restarting. It could also require changes in the generating mix to include more baseload capacity, but a substantial reconfiguration of generating capacity is costly and takes time. Higher peak demand would also lead to changes in

The Nuclear Waste Policy Act

The disposal of high-level radioactive waste from nuclear powerplants has long been perceived as a vexing problem. The Nuclear Waste Policy Act of 1982 establishes the Federal programs necessary to deal with nuclear waste.

The Act requires the establishment of permanent repositories to handle high-level radioactive spent fuel by January 31, 1998, and provides for Federal interim storage of up to 1,900 metric tons of spent fuel from utilities unable to provide necessary on-site storage of spent fuel. Both of these programs are to be funded by a user fee of 1 mill per kilowatt-hour, paid by nuclear utilities.

The Act charges the Department of Energy with the establishment of test and evaluation facilities for research, development, and demonstration efforts regarding disposed spent fuel, and requires the development of a proposal for construction of one or more monitored retrievable storage facilities. Procedures for repository site selection and rights of disapproval by affected States are provided for in the Act.

the capacity mix in order to satisfy the additional power load, but the necessary additions would likely be peakload capacity types such as turbines. An increase in the peakload would also decrease capacity utilization and increase fuel consumption, particularly oil and gas, resulting in higher prices.

Another source of uncertainty is the outlook for nuclear electricity generation. The recent history of the nuclear power industry has been marked by cancellations and deferrals of scheduled plants. There have been no new domestic orders for nuclear powerplants since 1978, although some of the reasons, such as declining demand growth and financial difficulties, have involved the entire electric utilities industry. However, these problems are particularly important in the nuclear power industry because it generally involves larger units and higher capital costs.

The industry faces further uncertainty in the future as the cost and impact of current and proposed safety measures have eroded nuclear power's perceived economic advantages over other types of baseload electricity generation. Some of the safety concerns may be relieved by the recent passage of the Nuclear Waste Management Act of 1982. This Act establishes procedures and major milestone dates for the Nation's nuclear waste management programs and if implemented on schedule, it is expected to alleviate much of the uncertainty about nuclear waste policy.

U.S.-Canadian Electricity Trade

In recent years, imports of Canadian electricity have become a significant component of electricity supply in parts of the United States. It is likely that these imports will increase over the next few years. U.S. utilities purchase electricity from Canadian utilities (or from other U.S. utilities) when that electricity costs less than electricity produced by the buyer's own generating capacity. Factors that encourage purchasing power are seasonal and daily diversity of demand, reliability requirements, and the mix of different generating technologies.

Although output from Canadian thermal generation is sold to U.S. utilities, most of the imported electricity is from Canadian hydroelectric capacity. In recent years, Canadian utilities have increased their generating capacity in anticipation of increased electricity demand and to exploit their abundant hydroelectric resources. Because Canadian electricity demand growth has been less than anticipated, the Canadian electric utilities have excess generating capacity. This capacity can be used to generate electricity for sale to U.S. utilities.

The price charged by the Canadian utilities determines the extent to which this source is used. U.S. utilities will continue to buy Canadian electricity so long as that electricity is competitively priced with U.S. generation, including the cost of transmission. At present, much Canadian electricity is priced at a percentage of U.S. utilities' avoided costs. Avoided costs are the operating costs the buyer would incur if it produced the power with its own generating capacity.

There are opportunities for continued U.S.-Canadian trade based on seasonal diversity, system reliability and convenience, entitlements to shared water resources, and economy. The existing interconnections between U.S. and Canadian utilities improve the stability and reliability of the electric power systems in both countries and facilitate large, short-term transactions. These supply and demand considerations underlying existing trade between the United States and Canada are used to make assumptions for the electricity forecasts in this volume.

A recent EIA study, U.S.- Canadian Electricity Trade (DOE/EIA - 0365) examines current trading patterns and the potential for continuing electricity trade.

Nuclear generation in 1982 increased by about 4 percent over 1981,[21] at a time when overall electricity generation decreased by about 2 percent. Nuclear energy is projected to be the fastest growing source of domestic energy in the near future, as plants currently in the construction "pipeline" are completed. However, the near-term growth of nuclear power will be limited to completions of projects currently being built. Because of high reserve margins, continued low growth in electricity demand, and lengthy construction periods, the completion of any "new starts" would occur after 1990.

Another potential problem involves the average age of fossil fuel power plants in operation. Reductions in new capacity additions have placed a greater burden on existing plants. Older plants are generally less efficient and require more input fuel per unit output. This could also lead to a reduced reliability for electricity supply since older plants are liable to have higher outage rates due to more frequent breakdowns and greater preventive maintenance needs.

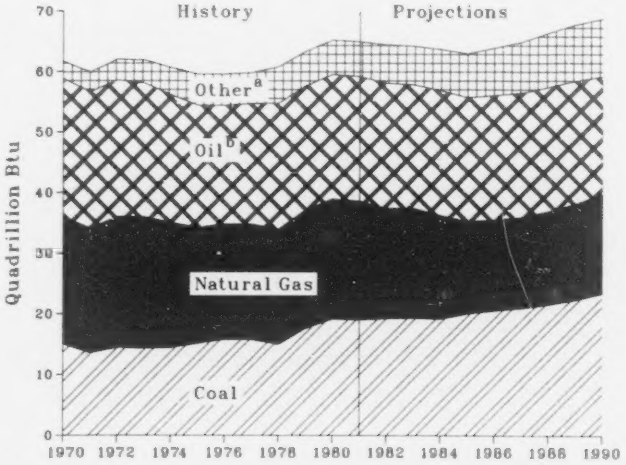
An increasingly important source of electricity has been imports from Canada. In 1981, Canadian electricity imports totalled 35.4 gigawatt-hours.[22] Although these imports were less than 2 percent of domestic sales, they were significant sources of energy in some regions, accounting for about 10 percent of electricity sales in New York and more than 5 percent in New England. Vast potential hydroelectric developments in Canada could supply parts of the United States if the economic and political climates are favorable in the future. However, these sources will take years to develop and the major impacts are beyond the time horizon of this study (see box for more details).

Supply of Energy

Except for oil imports, the United States is essentially self-sufficient in fossil fuels. A major coal exporter, the United States produced almost all of the natural gas it used in 1982, while 68 percent of U.S. oil consumption was domestically produced.

Coal production is projected to rise throughout the remainder of the 1980's, from about 19.2 quadrillion Btu in 1980 to 23.9 quadrillion Btu by 1990 (see Figure 23.) In contrast, domestic oil production is projected to remain relatively stable, rising slightly until 1984 and then decreasing slightly. Imports of oil would be expected to rise substantially from 1982 levels with economic recovery. Increased oil consumption is met by increased net imports, which rise from 4.2 million barrels a day in 1982 to 7.1 million barrels a day by 1990 in the midprice projection. Projected natural gas production declines through the middle years of the decade, rising at the end of the period.

Figure 23. Domestic Energy Production by Source, Midprice Scenario, 1970 to 1990 (Quadrillion Btu)



[a] Includes nuclear power, hydropower, geothermal energy and electric utility consumption of wood and waste.

[b] Includes natural gas plant liquids.

Source: Historical data: Energy Information Administration, 1981 Annual Report to Congress, Volume 2, DOE/EIA-0173(81)/2 (Washington, D.C., 1982), and Monthly Energy Review, DOE/EIA-0035(83/2) (Washington, D.C., 1983).

Oil Supply and Refining

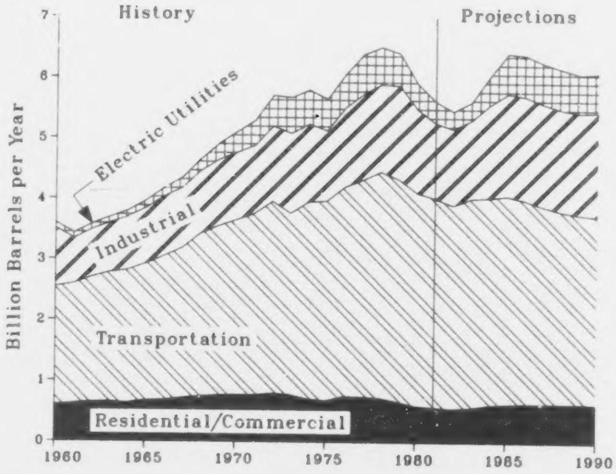
The United States has experienced several favorable trends in oil markets over the past few years, with stable domestic production and declining petroleum consumption and imports. These trends, however, are likely to change in the near future: domestic production will likely resume its long-term decline, and the declines in both consumption and imports will likely reverse. To understand these conclusions, it is useful to look at recent trends in oil markets as they reflect the influence of the determinants of oil supply and demand. Oil consumption is shown in Figure 24.

The key determinants of oil supply include the remaining resources to be discovered, the level of drilling activity, the rate at which existing reserves are produced by conventional means, and the expanded use of enhanced oil recovery techniques. In 1980, the U.S. Geological Survey estimated remaining undiscovered resources for oil to be 82.6 billion barrels.[24] To put this in perspective, proved reserves of crude oil, including lease condensate, at the end of 1981 were 29.4 billion barrels, and average production for 1982 was 8.67 million barrels per day, including lease condensate.[25]

An estimate of remaining undiscovered resources indicates the volume of oil left to be found that is also expected to be both profitable and technologically producible. The quality of what is left determines the economics of exploration and production. The amount of oil discovered (or producible reserves added per exploratory well, known as the finding rate) provides a simple measure of the efficiency of the exploratory effort and the quality of the resource base. The average for 1969 through 1972 was 179,500 barrels per well. Between 1977 and 1980 the average had fallen to 86,300 barrels per well. Part of the drop was due to higher prices that made smaller and formerly uneconomical finds profitable, lowering the average amount of oil or gas found per well. At the same time the costs (in 1972 dollars) to complete an oil well increased from a $92,400 average over the time period 1969 through 1972 to $140,800 in 1977 through 1980.[26] The rapid increases in oil prices so increased the number of available, profitable opportunities that some of the increased drilling costs, beyond the rate of inflation, are due to the rapid acceleration in drilling activity. The rest of the increased costs, however, come from drilling for deeper reserves or in areas with less favorable geological or environmental conditions.

If oil prices had remained constant over this period, oil drilling would have been substantially lower than actually occurred. The ending of domestic price controls and increasing world oil prices through 1981 spurred domestic drilling to record levels. In 1980 crude oil reserve additions matched production for the first time since 1970. When natural gas liquids are combined with crude oil, 1981 reserve additions also equaled production. The combined reserves were 36.5 billion barrels, at the end of 1981.

Figure 24. Oil Consumption by End Use, Midprice Scenario, 1960 to 1990 (Billion Barrels per Year)



Note: Industrial oil consumption excludes refinery fuel use.

Source: Historical data: Energy Information Administration, State Energy Data Report, 1960 through 1980, DOE/EIA-0214(80) (Washington, D.C., 1982), and Monthly Energy Review, DOE/EIA-0035(83/2) (Washington, D.C., 1983).

By the end of 1982, indicators of drilling activity were giving conflicting signals. Although the number of rigs in operation decreased in 1982, the number of reported well completions and total footage drilled increased. Because of the lag in the reporting well completions, the sharp decline in rig activity during the last half of 1982 is expected to be reflected in 1983 well completion and footage statistics. It is not yet known what impact this decline will have on discoveries. Nevertheless, the combination of high interest rates and recent declines in oil prices broke the speculative bubble in drilling activity.

Total domestic production rates have been much more stable than either drilling activity or reserve additions. In a sense, domestic production reflects previous years' reserve additions, since a successful well produces over many years. The rate at which a field can produce depends upon the initial volume discovered, how long the field has already produced, and on how intensively it is developed. In general, the more wells that are producing, the faster the rate of production and depletion. From the recent low of 8.1 million barrels per day in 1976, total domestic crude oil production has been on a plateau of 8.6 million barrels per day since 1979.[27]

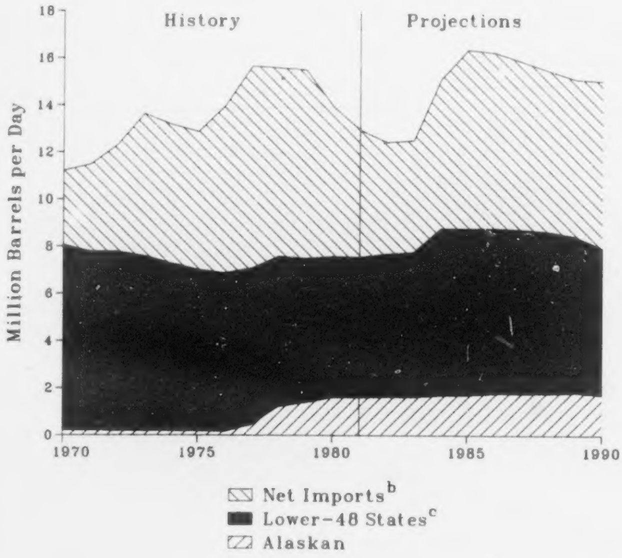
Since 1980, the major sources of crude oil supply (onshore production regions in the Lower-48 States, offshore fields and Alaska) have remained relatively constant. However, over the course of the 1970's the sources have shifted significantly. Lower-48 offshore production has declined from its peak of 1.7 million barrels per day in 1971 to 1.03 million barrels per day in 1981[28] and is expected to remain at approximately that level through this decade (see Figure 25).

Lower-48 onshore production has, however, declined from 7.8 million barrels per day in 1970 to 5.9 million barrels in 1981, a trend which is expected to continue with the exception of a slight upturn through 1983. This decline has been offset by the production of oil from Alaska. Alaskan production increased from .2 million barrels per day in 1970 to 1.6 million barrels per day in 1981,[29] and is projected to increase to a peak of 1.8 million barrels by 1989.[30]

One of the important changes in the energy picture over the recent past has been the steep decline in consumption since 1978 (see Figure 26). Between 1978 and 1981, consumption fell 15 percent. The effect on oil imports has been dramatic: gross petroleum imports, excluding crude oil imported for the Strategic Petroleum Reserve, have fallen from the 1977 peak of 8.8 million barrels per day to 5.7 million barrels per day in 1981, a 35 percent decline. If imports had remained at the same level as 1977, the 1981 expenditures on imported oil would have been 112.6 billion dollars instead of 76.2 billion.[31]

Petroleum consumption is expected to increase with economic recovery. Two other factors are likely to affect future petroleum consumption. First, with stable or declining world oil prices, the incentive for further conservation is being reduced. Second, since petroleum products and natural gas are competitive in many uses, consumption is linked. Continued gas price increases will stimulate switching to petroleum products.

Figure 25. U.S. Oil Supplies By Source,[a]
Midprice Scenario, 1970 to 1990
(Million Barrels per Day)



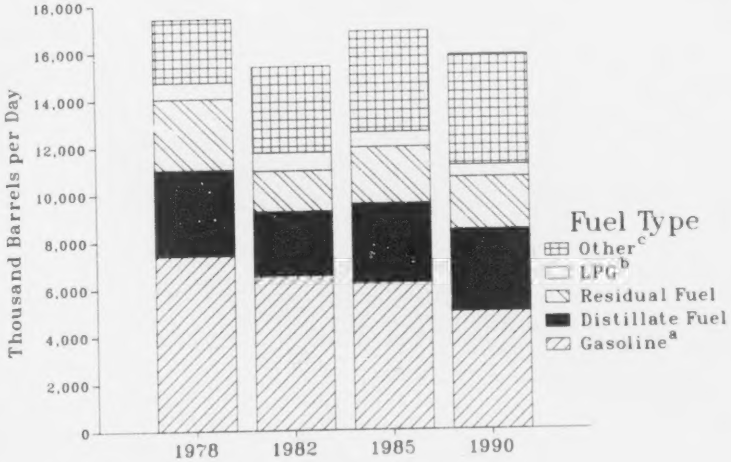
[a] Excludes domestic production of natural gas plant liquids.

[b] Includes imports for the Strategic Petroleum Reserve.

[c] Includes offshore production.

Source: Historical data: Energy Information Administration, 1981 Annual Report to Congress, Volume 2, DOE/EIA-0173(81)/2 (Washington, D.C., 1982), and Short Term Energy Outlook, Volume 1, DOE/EIA-0202(83/1Q)/1 (Washington, D.C.,1983).

Figure 26. U.S. Production of Petroleum Products, Midprice Scenario, 1978 to 1990 (Thousand Barrels per Day)



[a] Includes motor and aviation gasoline.

[b] Computed as domestic consumption of liquid petroleum gases (LPG's) used for heat and power minus net imports of LPG's. Refinery fuel use of LPG's is included, but LPG's consumed as feedstocks (and all ethane) are shown in Other products.

[c] Includes petrochemical feedstocks, ethane, natural gasoline, isopentane, unfractionated stream, plant condensate, other liquids, and all finished products not shown explicitly.

Source: Historical data: Energy Information Administration, 1981 Annual Report to Congress, Volume 2, DOE/EIA-0173(81)/2 (Washington, D.C., 1982), and Petroleum Supply Monthly, DOE/EIA-0109(83/2) (Washington, D.C., 1983).

Because of the crude oil price increases in the late 1970's, gas became the cheaper fuel almost everywhere in the Nation. With the recent gas price increases allowed under the Natural Gas Policy Act (NGPA), petroleum products have become more competitive in some areas of the country, and low-sulfur residual fuel oil may well recapture parts of the utility and industrial markets.

In 1981 and 1982 consumption requirements were met in part by drawing down petroleum inventories. This cannot continue indefinitely, and eventually increased imports are expected to fill the gap between consumption and production. In the midprice case, net petroleum imports are projected to grow to 7.1 million barrels a day in 1990 from 4.2 million barrels a day in 1982.

There are potential sources of domestic production to offset the need for increased imports. Newly explored areas in the offshore regions may contribute significant additions to reserves. There have been, for example, some important discoveries off the coast of California. New Alaskan leases may hold substantial potential, but given the climate and logistics problems, it could be many years before this potential is translated into production. However, increased reserves and production from the frontier areas will probably be offset by the continued decline in lower-48 onshore reserves and production.

The increased use of enhanced oil recovery (EOR) techniques may help slow the decline in onshore oil production. With conventional production techniques, only about 30 percent of the oil estimated to be in a field is producible. Current enhanced oil recovery techniques can increase the recovery of oil in place to as much as 40 percent. That is, existing reserves could be expanded by one-third, or 18 billion barrels, without any further exploration.[32] (Again, reserves are defined as oil that can be produced economically with current prices and current technology.)

Most EOR processes work by altering the flow characteristics of the oil. The most common technique at present heats the oil through steam injection, lowering the oil viscosity and enabling it to flow from the reservoir to the well. Many of the EOR techniques are experimental, but 4 percent of the Nation's oil was being produced by steam injection in 1982.[33]

Refineries. Decontrol of crude oil prices in January 1981 heralded major changes in the refinery industry. Substantial reductions in the consumption of petroleum for a variety of end uses occurred as well. At the same time, the protected status of a large percentage of small refineries under various provisions of the prior regulations effectively ended. These included not only access to crude oil but also cost advantages given small refiners. In 1981 and 1982, there has been a substantial reduction in refinery capacity as the industry realigned itself with the newer market conditions.

Refineries convert the mix of hydrocarbon compounds found in crude oil into a slate of marketable petroleum products. These products can be divided into two categories: lighter products, which include gasoline, distillate fuel, and jet fuel and heavier products, which include residual fuel oil, asphalts, lubricants, and petroleum coke. Refinery operations begin with a simple distillation process that separates the compounds found in the crude oil using differences in the boiling ranges of the compounds. Simple atmospheric distillation yields are about 10 to 20 percent gasoline and 30 to 40 percent residual fuel. End-use consumption of oil products, on the other hand, is 30 to 45 percent gasoline, and 10 to 20 percent residual fuel (see Figure 26). As a result, refineries require additional processes to transform the hydrocarbon molecules in order to change the yields coming from the distillation column into yields that are demanded by petroleum consumers.

Worldwide oil reserves contain a much higher proportion of "heavy" crudes than does the oil currently being produced and refined in the United States and overseas. Heavy oil presently sells at a discount to light oil because it cannot yield as high a percentage of the more valuable lighter products without further processing. A price differential of $8 to $12 per barrel appears to be large enough to pay the capital and operating costs necessary to "crack" heavy crudes and the residual from simple distillation into lighter products. As a result of the inevitable need to process heavier crudes and the economic advantage of upgrading heavy products into lighter products, refiners have proceeded with investments in "cracking capacity."

Cracking capacity includes thermal processes, such as cokers or new, heavy-feed catalytic cracking units and associated feed pretreatment and hydrogen manufacturing facilities, which break down the long molecules of heavy, low-quality crude oil and add hydrogen to form lighter products. There are approximately 25 such projects planned to open in the 1982 to 1984 period, representing a capital outlay over 5 billion dollars.

There are two other basic types of downstream processes that are used in refineries. These processes are "octane boosting" and desulfurization units. Octane is an indication of the antiknock quality of gasoline. As an alternative to refining higher octane gasoline refiners may add lead (tetra-ethyl) compounds to boost octane ratings of lower quality gasoline. Lead, though, is a potential source of pollution and its content in gasoline is limited by Environmental Protection Agency (EPA) regulations. Recent EPA rulings have further limited the amount of lead that refiners and blenders may use.

Another process used by refiners is desulfurization, which is a decontamination process that improves end-product quality. Sulfur dioxide is a gas that is emitted when fossil fuels containing sulfur are burned. These emissions are unhealthy, and many local governments have restricted the amount of sulfur that may be present in fuel. Desulfurization units process high-sulfur feed into low-sulfur fuel. Two factors affecting the increased need for these types of units are the increasing availability of heavier poor quality crudes relative to better quality crudes and a shift in demand to low-sulfur fuels from high-sulfur fuels. In 1981 low-sulfur residual fuel constituted 46 percent of total residual demand. This percentage is projected to rise to 52 percent by 1987.

At the same time that investment in downstream processes has occurred, smaller, simpler refineries have been closing. In 1978 total product consumption exceeded total refining distillation capacity by 2 million barrels per day. By year end 1982 operable crude distillation capacity exceeded consumption by about 1.5 million barrels per day even though some 75 refineries with a total 1.5 million barrels per day of distillation capacity had closed between 1980 and 1982.

The new equipment used to convert heavier crudes and excess residual fuel oil to lighter products is expensive and requires large amounts of capital. Between 1982 and 1990 downstream cracking capacity is projected to increase at an annual rate of about 2 percent. As this capacity comes on line, the supply of residual fuel oil will decline and its price will rise relative to crude oil and other products. Projected prices of petroleum products are shown in Figure 27.

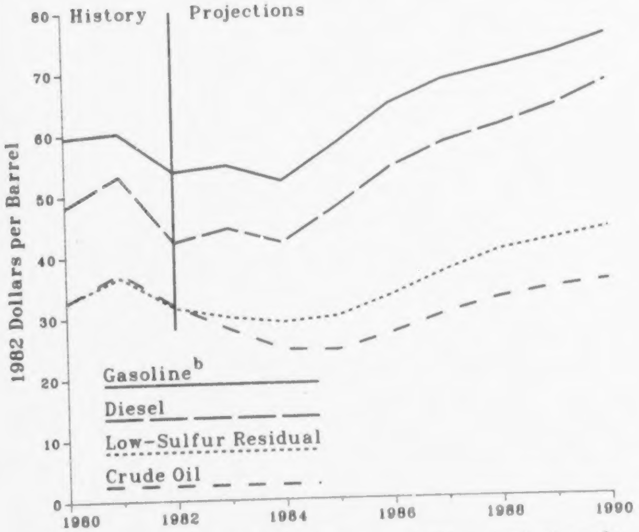
Natural Gas Markets and Supply

While oil prices have recently been stable or falling, the price of natural gas has risen rapidly. Between 1978 and 1982, the real average wellhead price of gas increased 95 percent, continuing the upward trend started in the mid 1970's (see Figure 28).[34] These increases have occurred in the face of stable or even declining consumption. The reasons for the recent price increases are related to the long history of natural gas regulations, to certain types of contractual relationships developed under those regulations and to decisions to buy long-term supplies of gas which seemed sound when they were made.

In the mid-1970's, the interstate gas market (gas bought for transportation and resale by pipeline companies that operate in more than one State) was characterized by supply shortages and resulting consumer curtailments. Interstate pipelines could not obtain the amount of gas their customers demanded at the price the Federal Power Commission permitted them to pay. The intrastate markets, unregulated at the Federal level, had plentiful gas, albeit at higher prices.

The Natural Gas Policy Act (NGPA) of 1978 (P.L. 95-621) established a new pricing structure, putting most gas under price ceilings based on the geology, distance from other wells, location, depth, and existing contractual arrangements for the gas, but creating a category of high cost gas free from price ceilings. The NGPA covered intrastate, as well as interstate, natural gas, thus eliminating a major distinction between the two markets. Price ceilings for new reservoir gas, Section 102 gas, were allowed to increase at a rate somewhat faster than inflation, but the Act limited the price of old gas to a relatively low amount. Pipeline companies, which had been unable to obtain sufficient supplies, bid readily for the uncontrolled gas and signed contracts which required most of the gas to be paid for even if not taken by the pipeline.

Figure 27. Prices of Crude Oil and Petroleum Products[a], Midprice Scenario, 1980 to 1990 (1982 Dollars Per Barrel)

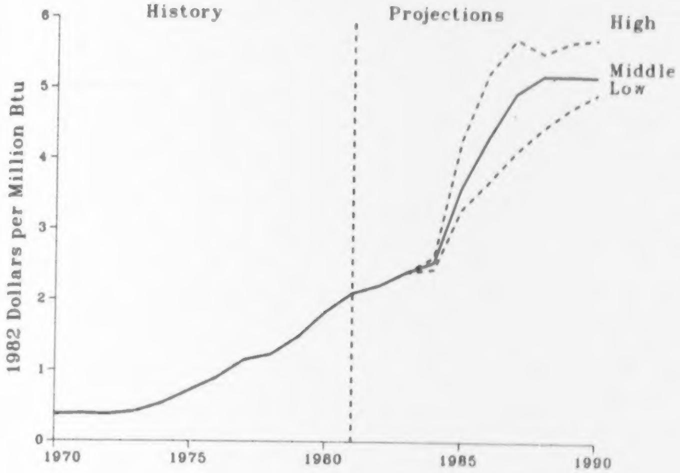


[a] Prices shown are the refiner aquisition cost of crude oil and end use product prices.

[b] Weighted average price of all types of motor gasoline.

Source: Historical data: Energy Information Administration, 1981 Annual Report to Congress, Volume 2, DOE/EIA-0173(81)/2 (Washington, D.C., 1982), and Monthly Energy Review, DOE/EIA-0035(83/2) (Washington, D.C., 1983).

Figure 28. U.S. Average Wellhead Price of Natural Gas, High, Middle and Low Price Scenarios, 1970 to 1990 (1982 Dollars per Million Btu)



Note: Prices converted from dollars per thousand cubic feet in the source to dollars per million btu using conversion factors from the Monthly Energy Review, DOE/EIA-0035(83/2) (Washington, D.C., 1983).

Source: Historical data: Energy Information Administration, 1981 Annual Report to Congress, Volume 2, DOE/EIA-0173(81)/2 (Washington, D.C., 1982).

Three factors have contributed to recent gas price increases:

1. The older, lower cost fields are slowly being depleted and, as a result, higher cost new gas is becoming a larger fraction of gas supply.
2. The prices of some new gas increase faster than the rate of inflation.
3. Contracts signed after passage of the NGPA require pipeline companies to take most of the higher cost gas covered under the contract, meaning that the pipeline buys less low cost gas when consumption falls.

In 1985, about half the natural gas production will be deregulated.[35] The effects of decontrol on prices will probably depend as much on existing contract provisions as upon underlying supply and demand conditions. Some contracts contain provisions providing that in the event of decontrol the price of gas will be established at a price equivalent to number 2 fuel oil, residual fuel oil, or some other commodity. In 1980, approximately 46 percent of the volume of gas delivered was covered by contracts containing "most-favored nation" clauses, which would come into play upon decontrol. These require that the gas covered by the contract receive a price as high as that received by other producers in the area.[36] The extent to which these contract provisions will raise gas prices to artificially high levels is very much uncertain at this point for several reasons. Two of these are the presence of "market out" clauses in some contracts, which give the purchasing pipeline relief if the gas cannot be resold, and the possibility that many contracts will be renegotiated. EIA is currently undertaking a detailed analysis of gas markets to resolve, and better represent, some of the issues presented by natural gas contracts.

During the last 2 years, there has been much public debate concerning the NGPA and its relationship to recent and continuing price increases. Many bills have been introduced in Congress to modify the Act and address perceived problems. On February 28, 1983, the Administration submitted the proposed "Natural Gas Consumer Regulatory Reform Amendments of 1983" to Congress. This proposed legislation would modify the NGPA to create a system in which prices may be more responsive to market pressures. Some provisions of the proposed bill are intended to protect consumers from sharp price increases and provide incentives to suppliers and pipelines to renegoitate contracts. The forecasts in this volume, based on legislation in place in February 1983, do not take account of the effects of the proposed Amendments.

Sources of Supply

Natural gas production is substantially similar to oil production as described in the previous section. In 1982, 21 percent of gas production was associated-dissolved gas, that is, gas found in the same deposits as crude oil and produced along with the oil. Natural gas and petroleum exploration and development projects compete for the same drilling rigs and other capital equipment. These strong links cause gas supply to be sensitive to world oil prices.

Currently, net domestic dry natural gas production is running at about 17.8 trillion cubic feet (or 18.1 quadrillion Btu) per year, about 73 percent from the onshore Lower-48 States and 26 percent from offshore. In addition, net imports provide about .9 trillion cubic feet, primarily by pipeline from Canada and Mexico. Domestic proved reserves of natural gas as of December 31, 1981, are 202 trillion cubic feet of dry natural gas, or about a 11-year supply at current levels of production.

Current production comes from proved reserves of gas. These reserves include nonassociated gas (gas from deposits that primarily produce gas) as well as associated-dissolved gas. The costs of recovering proved gas reserves vary greatly because of the location and physical characteristics of the individual reservoirs. For example, a single, large reservoir is generally less expensive to develop per unit of gas than many smaller reservoirs. In general, yearly additions to proved reserves (excluding reserves found in Alaska) have been smaller than production since 1967. In 1981 reserve additions were approximately equal to production.

Future production must come in large part from new deposits of gas, and these deposits will most likely be deeper, smaller, and more expensive to find and develop than currently producing deposits. Because it cannot be known whether gas (or oil) is present in a formation in quantities sufficient to warrant production until wells are drilled, projection of natural gas production is always subject to considerable uncertainty.

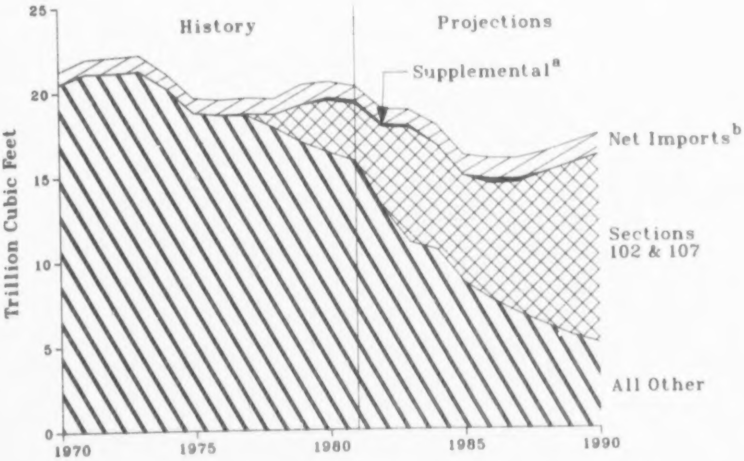
Figure 29 shows natural gas production from 1970 and projected to 1990. The area indicated as other is gas from deposits known and in production in 1977 and included in the lower-priced tiers of the NGPA pricing structure. The area marked Section 102 and 107 gas is largely gas from deposits developed since 1978.

The total production of natural gas is expected to decline from 16.7 trillion cubic feet in 1984 to 14.4 in 1986, then rise again to 16.1 in 1990. This is down approximately 3.4 trillion cubic feet from the 1980 production. What is particularly important to note is the source of the gas supply. Old reserves are being depleted and new reserves, those developed since 1978, must supply proportionately more of the gas. In 1980, this new gas constituted approximately 16 percent of domestic production. However, it increases to 42 percent of production by 1985 and 69 percent by 1990. The continuance of domestic production will rely for the most part on the exploration and development of new gas reserves.

Note that a major assumption underlying this year's forecasts is that the Alaskan pipeline will not be in service by 1990. The official start date for the Alaska natural gas transportation system project has been moved back to 1989. Given the issues yet unresolved concerning this project, it seems likely to face further delays and should not be included in the forecasts as a reliable source of supply in the current decade.

National average wellhead prices from 1970 and projected to 1990 are shown in Figure 28. Underlying these projections are the wellhead price

Figure 29. U.S. Supply of Natural Gas, Midprice Scenario, 1970 to 1990 (Trillion Cubic Feet)



[a] Delivered gas includes supplemental fuels (synthetic natural gas, etc.) that are not quantified separately from other domestic production prior to 1980. In projection years, the supply of supplemental gas is calculated as the difference between total domestic supply and the sum of new, old, and net imported gas.

[b] Includes imports of liquid natural gas.

Source: Historical data: Energy Information Administration, 1981 Annual Report to Congress, Volume 2, DOE/EIA-0173(81)/2 (Washington, D.C., 1982), and Monthly Energy Review, DOE/EIA-0035(83/2) (Washington, D.C., 1983), and The Current State of the Natural Gas Market, DOE/EIA-0313 (Washington, D.C., 1982).

controls of the NGPA. The depletion of the older, less expensive gas causes the new gas to be used in increasing amounts, accounting for the steady rise in prices.

A major price increase, or price "flyup," occurs in 1985 due to the expiration of NGPA price controls on most new gas in that year. A real increase of 42 percent in the wellhead prices in that 1 year occurs as a result of the lifting of price regulations on about half of the gas produced. Prices continue to increase the next several years as a smaller portion of lower priced gas is available and further price regulations are removed.

The production of natural gas is sensitive to the world crude oil price. Higher world oil prices stimulate the exploration and development of both oil and gas reserves and stimulate the demand for gas as a substitute for oil. In 1990, under the middle world oil price, domestic natural gas production is estimated to be 16.1 trillion cubic feet. However, this estimate declines to 15.1 trillion cubic feet under the low price oil price path but increases to 17.2 trillion cubic feet under the high price path.

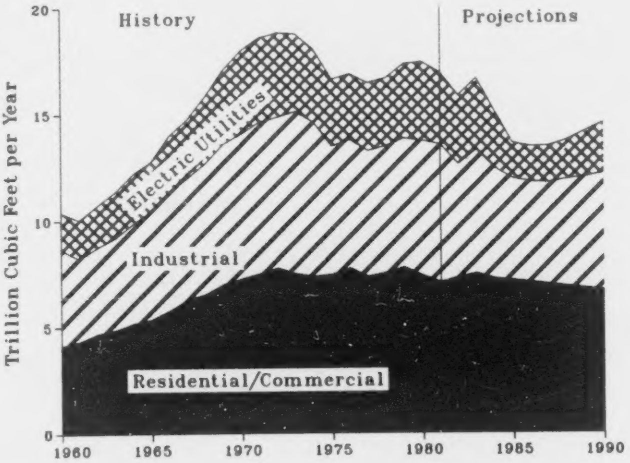
Higher production of gas is possible through higher prices, providing incentive for more costly, new gas reserves to be developed. Figure 28 depicts the wellhead prices of gas under each of the three world oil price paths. Note that the size of the flyup in 1985 increases or decreases with the world crude oil price.

The world oil price also affects the price and production of natural gas through the shifts in end-use consumption. Oil prices that are higher relative to gas prices will cause end-use consumers to shift from oil to gas, when possible, increasing both the price and production of gas. Figure 30 illustrates the historical and projected consumption of gas by end-use sector. That the electric utility sector in particular is capable of shifting between gas and oil is reflected in the drop in gas consumption in 1985. See the electric utilities section for further discussion of fuel switching in this sensitive sector.

Coal

From the end of World War II until recent years, coal gradually declined in importance as an energy source in the United States. From providing nearly 40 percent of the Nation's energy consumption in 1950, coal's share declined to 17 percent just before the 1973 oil embargo. Even when oil prices doubled following the embargo, coal's share of the U.S. energy market increased only slightly. It was not until after 1978 that coal's share of energy consumption began to increase. This movement was given additional stimulus by the second major jump in oil prices between 1979 and the end of 1980. Beginning in 1978 coal use has increased significantly (14 percent by 1982). While the recession caused a small decline in coal use in 1982, coal accounted for 22 percent of gross energy consumption in that year.[37]

Figure 30. Natural Gas Consumption by End Use, Midprice Scenario, 1960 to 1990 (Trillion Cubic Feet per Year)



Source: Historical data: Energy Information Administration, State Energy Data Report, 1960 through 1980, DOE/EIA-0214(80) (Washington, D.C., 1982), and Monthly Energy Review, DOE/EIA-0035(83/2) (Washington, D.C., 1983).

Although coal's relative share of the total domestic energy market has declined in the past 30 years, the quantity of coal consumed in the United States was 42 percent higher in 1980 than in 1950.[38] Also, dramatic changes have occurred in the markets for coal. Before and immediately after World War II, coal was burned directly to produce energy and was a major residential, industrial, and transportation fuel (see Figure 31). In 1950, for example, coal heated nearly 35 percent of the homes in the United States--more than any other single fuel. Within 20 years, however, coal's share of the residential heating market had dropped to 3 percent, and today is less than 1 percent. An even more rapid shift away from coal occurred in the transportation sector from 63 million tons in 1950 to less than .05 million tons in 1982. Coal is used primarily as a boiler fuel to generate steam which, in turn, is used most often to generate electricity. Indeed, the growth of electricity use accounts for most of the increase in coal use over the last 30 years. Industrial coal use ended its long decline in the late 1970's, and has been growing since, with the exception of mild reductions in 1980 and 1982, reflecting declines in industrial activity.

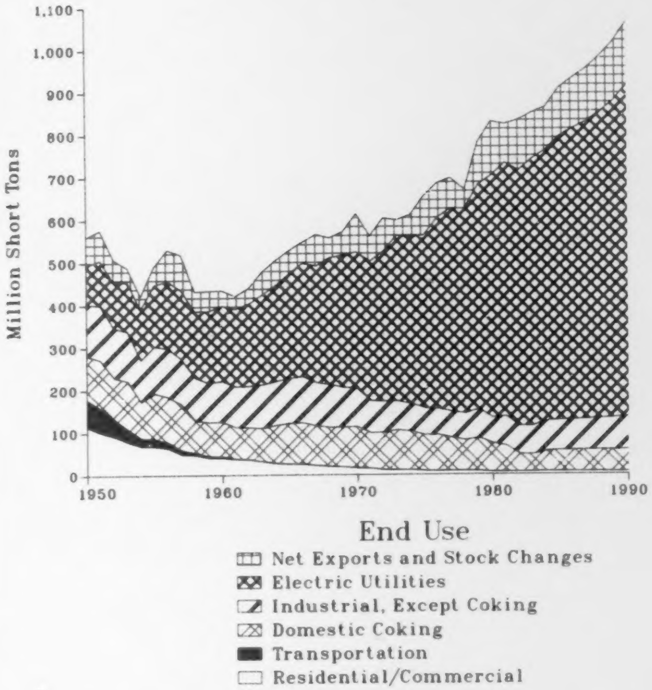
The coal industry has the capability to produce up to 100 million tons more coal per year than currently produced; coal production in the United States is limited more by demand than by supply. The coal reserve base in the United States is one of the largest in the world. The most recent estimate places it at approximately 473 billion tons, of which about 246 billion tons are considered recoverable by conventional mining techniques. This estimate represents about 25 percent of the known recoverable reserves in the world, more than the coal reserves of any other free world nation, and about 9 times the Btu equivalent of recoverable oil and gas reserves in the contiguous United States and Alaska.[39]

To meet the projected growth in both domestic and foreign demand for coal, U.S. coal production is projected to grow by 2.2 percent per year from 1980 to 1990.[40] Coal is projected to provide approximately 25 percent of the Nation's gross energy consumption in 1990 compared to about 20 percent in 1980.

The driving force behind increased coal use and production, as discussed in the utilities and industrial sections, is the relatively low price of the fuel. For example, the average price of coal to utilities in 1990 is projected to be only 1.86 (1982 dollars) per million Btu in the midprice case.

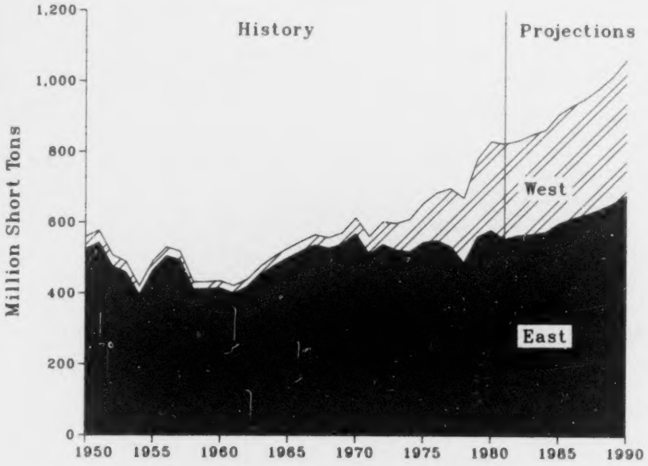
Residual fuel oil, on the other hand, is projected to cost 6.53 (1982 dollars) per million Btu. As a result, new, large fuel-burning installations operated by utilities and large industrial facilities tend to use more coal. Utility use, for example, is projected to rise by 3.0 percent per year between 1980 and 1990. The geographic location of coal mining activities is also changing. During the 1970's, the share of coal produced west of the Mississippi increased significantly, and this trend is projected to continue. In fact, the midprice projections show 36 percent of U.S. coal production coming from west of the Mississippi by 1990 (see Figure 32).

Figure 31. Coal Consumption by End Use, Midprice Scenario, 1950 to 1990 (Million Short Tons)



Source: Historical data: Energy Information Administration, 1981 Annual Report to Congress, Volume 2, DOE/EIA-0173(81)/2 (Washington, D.C., 1982), Monthly Energy Review, DOE/EIA-0035(83/2) (Washington, D.C., 1983), and Weekly Coal Production, DOE/EIA-0218, selected issues.

Figure 32. Coal Production by Major Producing Region, Midprice Scenario, 1950 to 1990 (Million Short Tons)



Source: Historical data: U.S. Department of the Interior, Bureau of Mines, Minerals Yearbooks, (Washington, D.C.) selected years; Energy Information Administration, 1981 Annual Report to Congress, Volume 2, DOE/EIA-0173/(81)/2 (Washington, D.C., 1982) and Weekly Coal Production, DOE/EIA-0218, selected issues.

Staggers Rail Act of 1980

Rail transportation that involved movements across State boundaries was totally regulated by the Interstate Commerce Commission (ICC) until the passage of the Staggers Rail Act of 1980. All rail tariffs had to be published. Generally, the ICC required that rail rates be between out-of-pocket cost and average total cost. However, the relatively large fixed cost of providing rail service and problems with allocating joint costs made it difficult to calculate these cost limits.

At the time of the enactment of the Staggers Rail Act, the Congress recognized that many of the Government regulations affecting railroads had become unnecessary and inefficient and that earnings of the railroad industry, lowest of any transportation mode, were insufficient to generate funds for future capital improvements.

The Act limits the Federal Government regulation of railroads to those situations in which the market is not an efficient allocator of transportation services. For the first time since the establishment of the ICC, the Act permits shippers and railroads to enter into bilateral contracts for rates and services outside of ICC jurisdiction. However, the regulatory umbrella of the ICC is continued for captive shippers over which railroads hold market dominance. A captive shipper is usually defined as a shipper for whom a single railroad represents the only source of transportation for the entire shipment or for a substantial share of the route.

Much coal transportation (especially to electric utilities) is provided under long-term contracts. In general, these contracts could moderate increases in coal haulage rates over the next few years.

Several factors explain this regional shift in the coal production pattern. Among the most important of these is the sulfur content of the coal. Sulfur in the coal is released into the atmosphere by combustion. The easiest way to improve air quality is to reduce sulfur dioxide emissions by burning low-sulfur coal when possible. Most of this low-sulfur coal is located in the western United States and has to be transported long distances to major coal users in the East. In addition, increasing western consumption is also satisfied by the low-sulfur western coal.

However, coal is, by its very nature, bulky and expensive to move from place to place. In 1981, 64 percent of coal movements were by railroad and 11 percent by barge with coal slurry pipelines and trucks providing the remaining haulage. Unit train rates over moderate distances run roughly 2 to 4 cents per ton-mile with shorter hauls (less than 500 miles) being in the higher range. In places far from the western coal fields, the cost of transportation greatly reduces the cost advantage that western low-sulfur coal has over eastern high-sulfur coal and other fuels. On a rail movement from Wyoming to Ohio, for example, transportation charges can amount to well over half the delivered price of the coal. Increases in rail rates, permitted by greater rate flexibility under the Staggers Rail Act of 1980, may tend to slow the production of Western coal as delivered prices rise to midwestern and southwestern markets.

Coal Exports

The use of steam coal has been expanding world wide as nations have sought to become less dependent upon oil imports from OPEC. The United States, Australia, South Africa, and Poland are currently the primary coal exporters. Each country has abundant coal reserves and is expected to continue as a major participant in the world coal market through 1990. Australia is expected to be the major competitor of the United States in the Far East, and South Africa the main competitor in the Western European coal market. The delivered cost of U.S. coal is higher than that of the other suppliers, but the United States is the only nation whose export capacity is not limited by loading, transportation, or financial constraints.

As foreign countries have shifted consumption towards coal, U.S. exports of coal have risen rapidly over the last 4 years, especially exports of steam coal from the east coast. Although exports of metallurgical coal are expected to be relatively stable during the next decade, exports of steam coal are expected to rise slightly by 1985 and then to begin increasing at a faster rate, reaching a level of 82 million short tons by 1990. Most of the exports are expected to be shipped from east coast ports.

U.S. Coal Exports, 1979-1990
(Million Short Tons)

	Actual				Projected	
Coal Type	1979	1980	1981	1982	1985	1990
Steam Coal	14	27	45	41	51	82
Metallurgical Coal .	51	63	65	65	58	61
Total Export	65	90	110	105	109	143

Note: All figures exclude exports of anthracite and lignite coal. Totals may not add due to rounding.
Source: 1979-1982 -- Energy Information Administration, Weekly Coal Production DOE/EIA-0218 (83/05), (Washington, D.C., 1983) Table 27, p. 33.

Energy Economy Interactions

An essential part of any examination of the energy sector is a review of its relationship to the rest of the economy. In nominal (current dollar) terms, the energy sector has risen from only 5.7 percent of total U.S. economic output in 1972, to approximately 11.5 percent in 1982,[41] due to the dramatic rise in energy prices over the last decade. The energy price shocks experienced in the 1970's were imposed by forces outside the United States, and yet they had an enormous effect on the daily life of every American.

If energy prices change significantly, both the inflation rate and the rate of unemployment for the whole economy can be affected. The rate of unemployment will change if the level of overall economic activity measured by such indices as the growth rate in Gross National Product (GNP) or the level of production in manufacturing is affected. Through effects on the actual or expected inflation rate, changes in energy prices may also affect the general level of interest rates, such as money market rates, mortgage rates, and the prime rate. Sudden, unanticipated jumps in the price of energy have especially important effects on all of the above variables.

During the past decade, energy prices have had a particularly significant role to play in determining the course taken by the economy. The two oil price shocks, of the 1973-1974 and 1978-1980 periods, are widely considered to be responsible for part of the increased inflation experienced during the last 10 years. During this period, the annual rate of increase in the Consumer Price Index (CPI) jumped from a relatively low level (4.6 percent at a compound annual rate from 1968 to 1972), to a rate of 13.5 percent for the year in 1980. While not all of the increased inflation can be blamed on energy prices, increased oil import prices obviously made the job of maintaining both economic activity and stable prices extremely hard. Had policies been pursued to repress all the inflationary effects of these energy price shocks, higher unemployment than was actually experienced might have been the result.

The processes by which energy price shocks are transmitted to both the general price level and the level of unemployment are complex, with some causes easier to follow than others. In the case of the link to general price inflation, it is easy to see that as the cost of energy rose, particularly imported energy, some real cost to the economy had to be reflected in changes in the general level of prices. As manufacturers in this country experienced increased energy prices at the production level, at least part of the increased energy costs would be passed on to consumers as higher prices for a great variety of goods. At the same time, increases in the actual and expected inflation rates experienced by workers led them to demand greater wage increases, thus beginning a second round in the inflationary spiral. The ultimate change in the inflation rate depends upon monetary and fiscal policy responses as well as reactions in the private sector.

The effect of energy price shocks on the unemployment rate is somewhat more complex, since there is both the general effect of energy prices on the level of economic output to consider, as well as the degree to which increases in the price of one input to production (energy) may lead to producers substituting more of another input (labor) in the production process. While the effect of energy prices on output in general may be assumed to have predominant importance in the short run, it is necessary in the long run to take account also of the specific effects of energy price increases on both the demand and supply of labor. If energy prices increase to a permanently higher level, for example, the net effect on producers may be that they demand relatively more labor per unit of output, in industries where labor can be substituted for energy.

Despite these complexities, the dominance of output in determining the overall unemployment situation argues for concentrating attention on the effects of energy prices on the level of economic activity in general, as measured by various aggregate indices. Real GNP (evaluated at constant base year prices) is adversely affected by increases in the world price of oil. The fact that a significant part of the energy supply of the United States is in the form of imported oil is an important part of any analysis; if this were not true, an increase in the world market price of oil, or any other kind of energy, would not necessarily have important adverse consequences for the level of economic activity in the United States. If the United States were not a net importer of oil, increased oil prices might simply result in a redistribution of income within the domestic economy, and regional effects would be more important than national impacts. Because the domestic economy is still dependent upon foreign oil, however, a significant increase in the price of this commodity has immediate adverse effects upon the United States merchandise trade balance, and as the net amount of dollars paid out to foreigners increases, the domestic economy is correspondingly depressed.

While eventually these U.S. dollars may return to the economy as claims on real goods and services, less of the potential aggregate supply would then be available for domestic consumption.

Of course, the United States is less vulnerable to the degree that it is less dependent than previously upon imported oil -- the level of imports has been cut considerably since its peak of 8.8 million barrels per day in 1977. Nevertheless, even at a level of imports of only 4 million barrels per day, the effect of a $5.00 per barrel shift on the trade balance is still over $7 billion per year. Because this money is spent abroad and, in the near term, only partially respent back in the U.S., the level of disposable income in the United States is reduced in the short run by energy price shocks, and households (paying more for energy) must cut back expenditures on both energy and nonenergy goods.

Due to the near term effects on incomes and economic growth, as well as more permanent effects on the relative attractiveness of energy as an input to production, important long-term effects on productivity and investment result from a sharp, and sustained, energy price increase. Higher energy prices tend to make some capital (plant and equipment) designed for a world of cheaper energy prices obsolete; as this part of the capital stock is retired more quickly, and priority is given to investment in energy-saving capital equipment, other planned investments must be postponed, and the effort to "catch up" with higher energy prices may diminish productivity growth normally associated with new investment.

In addition, the short-run reduction in economic activity accompanying an energy price shock will lead to generally lower levels of investment until the economy recovers, further slowing down the rate of productivity growth in the long run, since new capital stock is put in place more slowly. Ultimately, as the economy adjusts to higher energy prices, some of the economic growth apparently "lost" in the initial reaction to the shock may be recovered, but it is unlikely that all of it would be regained.

Similar considerations apply if energy prices move both sharply upwards and sharply downwards over time, but the effects of declining prices are more mixed. On the one hand, downward price movements will always have certain beneficial effects on the economy -- reduced inflationary pressures, stimulus to incomes and employment, improved terms of trade. On the other hand, unstable energy prices makes both financial and real investment inherently more uncertain, and thus it is possible to incur economic losses due to adjustments costs. Nevertheless, the fundamental point that generally downward movements in the oil price are good for the U.S. economy remains true.

Many efforts to quantify the economic effects of changes in the energy sector have been made in recent years. The literature on this subject is quite large, and only a few studies can be mentioned in this brief discussion.

One economist, William Nordhaus, used a small macroeconomic/energy model of the U.S. in order to measure the effects of higher oil prices in the 1973-1979 period.[42] He concluded that "inflation was almost two-thirds percentage points a year higher during the 6 years while real income per worker grew 0.5 points a year slower". Investment activity was also found to be significantly depressed by higher world oil prices.

In another study taking a retrospective look at the 1974-1975 experience, Knut Mork and Robert Hall also concluded that the impact on the economy of the OPEC price shock was substantial.[43] The energy price shock accounts for a decline in real output by 2 percent in 1974 and by 5 percent in 1975. This is roughly two-thirds of the total divergence in real output from the trend. Mork and Hall continued their work on the subject with a look at the energy price shock commencing in 1978.[44] This shock had a somewhat smaller impact than the earlier 1974-1975 shock. Real output was depressed by 1.1 percent in 1979 and 2.8 percent in 1980. As with the previous analysis, investment activity is significantly curtailed.

While the above studies have investigated the impacts of past energy shocks, a number of studies have analyzed the potential impacts of future price shocks. A recent study prepared by the Congressional Budget Office uses the DRI Quarterly model to assess two disruption scenarios, each of 1 year duration and occurring in 1982.[45] When faced with a world shortfall of 3.0 million barrels per day real GNP declines by an average of 1.6 percent for the five quarters after the disruption. In an even larger disruption case the world shortfall is 7.5 million barrels per day, the negative impacts on the economy averages 4.3 percent for the five quarters after the disruption.

Edward Novicky presents a similar analysis of alternative sized disruptions. He postulates four disruptions of worldwide supply between 7 and 14 million barrels per day.[46] He finds that GNP losses rise much more than proportionately to the size of the disruption. Doubling the size of a U.S. shortfall would cause the decline in GNP to more than double. This result is typical of much work, and results from the increasing marginal value of oil as curtailment of supply increases in severity.

A forthcoming EIA survey of research on oil price effects on the economy[47] draws from some of the studies mentioned above and others to bring into focus current thought on the issue. The paper compares EIA simulation results to simulation results extracted from a review of the literature and also to recently released results from the Energy Modeling Forum[48] at Stanford University.

On average, the studies surveyed indicate that a 25 percent increase in world oil prices would tend to reduce GNP by 1 percent. Oil prices rise very rapidly as the severity of a disruption increases. As a result, a 250 percent increase in price gives rise to a 5 percent first-year loss in real GNP.

Comparison With Other Forecasts

A number of factors have caused the projections presented in this volume to differ from those contained in the 1981 Annual Report. Among these are recent events in world oil markets, (leading to lower world oil price projections) somewhat less optimistic macroeconomic assumptions, uncertainty about projected natural gas and coal prices, updates and revisions in data, and the reestimation of demand relationships based on new information. This year annual projections are presented rather than values for 1985 and 1990 alone. Table 9 presents a summary of recent forecasts. In 1990, total projected energy supply is about 4 quadrillion Btu less than in the 1981 Annual Report. This is a net change reflecting an increase of 3.0 quadrillion Btu in net energy imports and a decline of 7.3 quadrillion Btu in domestic energy production. The decline in projected domestic coal production, nuclear power and hydroelectric power accounts for approximately 65 percent of this decrease in domestic energy production, while oil and gas account for the remainder. The projected decline in domestic coal production results from reduced electrical utility and industrial demand for coal. Projected lower levels of nuclear plant utilization, cancellations, and postponement of plant startups explain the 1.3 quadrillion Btu decline in nuclear power supply. Data revisions are the primary reasons for the decline in hydroelectric power supply.

Combined net oil and gas imports increase by approximately 3.6 quadrillion Btu between the 1981 and the 1982 midprice projections. Offsetting increased energy imports is an increase of approximately 0.3 quadrillion Btu in projected coal exports.

Table 9. Comparison of U.S. Energy Supply/Demand Detail for 1990
(Quadrillion Btu per year)
(Real 1982 Dollars)

	1982 AEO	1981 ARC[a]	DRI[b]	CHASE[c]	7/82 PPAE[d]
Domestic Energy Supply					
Oil......................	19.3	20.0	19.9	19.4	18.0
Natural Gas..............	16.4	18.1	15.9	17.8	18.4
Coal.....................	23.9	27.1	23.6	27.1	25.8
Hydroelectric power......	3.2	3.5	3.5	3.9	3.4
Nuclear Power............	6.3	7.6	6.8	4.3	7.3
Total Domestic Production..	69.1	76.4	69.7	72.5	72.9
Net Imports					
Oil......................	15.1	12.0	13.1	13.2	12.7
Natural Gas..............	1.2	.7	2.4	1.1	1.8
Coal.....................	-3.8	-3.5	-3.4	-3.8	-3.2
Total Supply	81.6	85.6	81.8	83.0	84.2
Consumption					
Residential..............	9.3	8.9	9.3	9.5	9.1
Commercial...............	6.9	5.9	6.5	6.8	6.4
Industrial...............	24.1	26.9	22.9	22.4	27.7
Transportation...........	16.9	17.7	19.1	17.8	16.7
Total End-Use Consumption..	57.2	59.4	57.3	56.5	59.9
Gross National Product (billions).................	3,920.4	4,062.1	4,021.7	4,047.1	--
Disposable Income (billions).................	2,719.2	2,844.5	2,824.2	2,874.5	--
World Oil Price (per barrel)...............	36.71	57.48	36.89	38.07	45.55

-- = Not applicable.

Table 9 (continued)

[a] For comparison, natural gas use in the transportation sector and lease and plant fuel natural gas in the industrial sector have been deleted.

[b] Industrial total excludes natural gas used a lease and plant fuel, hydroelectric power, solar, and exotic energy forms but includes natural gas used as a raw material. Transportation total excludes natural gas used as a transportation fuel.

[c] Sectoral consumption totals exclude electricity conversion losses and natural gas used as a lease and plant fuel and pipeline fuel have been excluded from the industrial and transportation sectors totals respectively.

[d] Renewable energy consumption has been excluded from residential, commercial, and industrial totals. Natural gas used by the transportation sector has been excluded from that sector's total consumption. Industrial sector total includes natural gas lease and plant fuel consumption, and asphalt which has been transferred from the commercial sector.

Sources:

Data Resources Incorporated, Data Resources Energy Review, Spring 1983. Volume 7 Number 1, (Lexington, Massachusetts, 1982).

Chase Econometrics, Energy Analysis Quarterly Third Quarter 1982, (Bala Cynwyd, Pennsylvania, 1982).

Energy Information Administration, 1981 Annual Report to Congress, Volume 3 DOE/EIA-0173(81) (Washington, D.C., 1982).

U.S. Department of Energy, Division of Analytical Services, Office of Policy, Planning and Analysis, July 1982 Energy Projections, (Washington, D.C., 1982).

Total projected end-use consumption declined by approximately 2.2 quadrillion Btu between forecasts, with a 1.4 quadrillion Btu increase in combined residential and commercial consumption being offset by a 3.0 quadrillion Btu decrease in transportation and industrial consumption. The increase in projected residential and commercial consumption reflects the impact of lower assumed oil prices. Projected industrial sector energy consumption decreases by approximately 2.8 quadrillion Btu; data revisions and reestimation of the projection system offset the effect of lower oil prices. Feedstock use declines by 2.2 quadrillion Btu, while heat and power uses account for the remainder of the decline. Transportation consumption declines by approximately .8 quadrillion Btu due to the projected increased efficiency of the vehicle stock and a lower projection of disposable income.

Footnotes to Chapter 3

[1] Fechtel, Brian R., Edward R. Novicky, and Arlene Ryan Wusterbarth, Energy Capital in the U.S. Economy (Bethesda, Maryland: MTSC, Inc., 1980), pp. 2.13.2, 2.12.3, 2.14.1.

[2] Various household populations in this paragraph from: U.S. Department of Commerce/Bureau of the Census, Housing Survey: 1980 General Housing Characteristics, (Washington, D.C., 1982).

[3] Estimates of end-use energy consumption were made in the Office of Energy Markets and End Use using the Residential Energy Consumption Survey data base covering the period April 1980 through March 1981.

[4] Historical values for energy consumption from: Energy Information Administration, State Energy Data Report 1960-1980, DOE/EIA-0214(80) (Washington, D.C., 1982); Historical values for households from: U.S. Department of Commerce, Bureau of the Census Annual Housing Survey: 1980 General Housing Characteristics, (Washington, D.C., 1980).

[5] Historical values for wood consumption are from: Energy Information Administration, Estimates of U.S. Wood Energy Consumption from 1949 to 1981, DOE/EIA-0341 (Washington, D.C., 1982).

[6] Historical data in the commercial sector discussion are from Energy Information Administration, State Energy Data Report 1960-1980, DOE/EIA-0214(80) (Washington, D.C., 1982), p. 16.

[7] The industrial sector includes manufacturing, mining, construction, and agriculture. However, lease and plant fuel, refinery fuel use, and fuel for transportation in agriculture and construction are excluded.

[8] U.S. Department of Energy, Office of Conservation and Renewable Energy, The Annual Report: Industrial Energy Efficiency Program (DOE/CS/0111) various dates.

[9] U.S. Department of Commerce, Bureau of Census. Hydrocarbon, coal, and coke materials consumed M80C(AS)-4.3 and 1980 Annual Survey of Manufactures Fuel and Electricity Consumed, Industry Groups and Industries M80(AS)-4.1 9 (Washington, D.C., 1982).

[10] International Energy Journal, July 1982, Volume XLIX, #7, pp. 286-290.

[11] R. Ball, "New Process A German Maverick Pioneer in Steel" Fortune, October 4, 1982, pp. 131-134.

[12] U.S. Department of Energy, Office of Conservation and Renewable Energy, Trends on Energy Use and Fuel Efficiency in the U.S. Commercial Airline Industry, (Washington, D.C., 1982), p. 6.

[13] Computed from information contained in Office of Conservation and Renewable Energy, Trends in Energy Use and Fuel Efficiency in the U.S. Commercial Airline Industry, (Washington, D.C., 1982), p. 14, Table 4.

[14] Computed from data in Energy Information Administration, Monthly Energy Review, DOE/EIA-0035(83/3) (Washington, D.C., 1983), p. 24-27.

[15] Computed from data in Energy Information Administration, 1980 Annual Report to Congress, Volume 2, DOE/EIA-0173(79)/2 (Washington, D.C., 1980).

[16] Computed from data in Energy Information Administration, Monthly Energy Review, DOE/EIA-0035(83/2) (Washington, D.C., 1983), p. 92.

[17] Computed from data in Energy Information Administration, Inventory of Power Plants in the United States 1981 Annual, DOE/EIA-0095(81) (Washington, D.C., 1983).

[18] Computed from data in Energy Information Administration, Monthly Energy Review, DOE/EIA-0035(83)/2 (Washington, D.C., 1983), p. 68.

[19] Ibid.

[20] Computed from data in Energy Information Administration, Monthly Energy Review, DOE/EIA-0035(83/2) (Washington, D.C., 1983).

[21] Ibid.

[22] Energy Information Administration, U.S.-Canadian Electricity Trade, DOE/EIA-0365 (Washington, D.C., 1982).

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[24] Energy Information Administration, Petroleum Supply Annual 1981, Volume 1, DOE/EIA-0340(81)/1, (Washington, D.C., 1982).

[25] Alaska Department of Revenue, Petroleum Production Revenue Forecast: Quarterly Report, (Juneau, Alaska, 1982).

[26] Energy Information Administration, Petroleum Supply Monthly, DOE/EIA-0109(82)/11 (Washington, D.C., 1982).

[27] Energy Information Administration, 1981 Annual Report to Congress, Volume 2 DOE/EIA-0173(81)/2 (Washington, D.C., 1982).

[28] Ibid.

[29] Ibid.

[30] Ibid.

[31] Energy Information Administration, 1981 Annual Report to Congress, Volume 2, DOE/EIA-0173(81)/2 (Washington, D.C., 1982).

[32] Energy Information Administration, Petroleum Supply Monthly, DOE/EIA-0109(82)/11 (Washington, D.C., 1982).

[33] Ibid.

[34] Energy Information Administration, 1981 Annual Report to Congress, Volume 2, DOE/EIA-0173(81)/2 (Washington, D.C., 1982).

[35] Energy Information Administration, The Current State of the Natural Gas Market, DOE/EIA-0313, (Washington, D.C., 1982).

[36] Energy Information Administration, Natural Gas Producer/Purchaser Contracts and their Potential Impacts on the Natural Gas Market, DOE/EIA-0330 (Washington, D.C., 1982).

[37] Energy Information Administration, Short-Term Energy Outlook, DOE/EIA-0202(82/4Q)1 (Washington, D.C., 1982).

[38] Computed from Energy Information Administration, Short-Term Energy Outlook, DOE/EIA-0202(82/4Q)1 (Washington, D.C., 1982); U.S. Department of Energy, Energy Information Administration, 1980 Annual Report to Congress, Volume 2, DOE/EIA-0173(80)/2 (Washington, D.C., 1981).

[39] Energy Information Administration, 1981 Annual Report to Congress, Volume 2, DOE/EIA-0173(81)/2 (Washington, D.C., 1982).

[40] Energy Information Administration, Short-Term Energy Outlook, DOE/EIA-0202(82/4Q)1 (Washington, D.C., 1982).

[41] Based on the Data Resources, Inc., Interindustry Model forecast of October 1982.

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[47] Earley, Ronald F. and Curtis, William P. "Impacts of World Oil Market Shocks on the U.S. Economy: Literature Review," (Washington, D.C. to be published).

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4. Energy Markets in the Longer Term

Since the oil crisis of 1973 to 1974, the United States has witnessed a set of events that, taken together, seem to indicate that the "energy crisis" is over. Some of the events indicate underlying changes to the economy, while others are shorter term events that cloud the analysis. For example, in the United States, new nuclear powerplant orders were virtually eliminated, while private and Government sponsorship of a synthetic fuels industry was initiated and largely withdrawn. Recently, domestic oil and gas drilling activity has declined.

These changes have been accompanied by significant declines in the per capita demand for energy. At least half of the homeowners have added insulation and/or taken other energy conservation measures in their homes. Industry has reduced its energy intensity (energy input per unit output), and automobiles have been made more energy efficient. Over the past few years, the international demand for oil has dramatically declined, contributing to the fall in the world oil price in real terms.

These recent events have shaped energy price perceptions and, hence, affected both energy supply and demand. Although price perceptions are formed in the short run, they affect the level and type of investment in new capital equipment that will operate in the long run. One effect of the perception that oil prices will not increase sharply and quantities will be readily available is that research and investment in synthetic fuels have nearly come to a halt. Only three synthetic fuel programs are still active, while scores were either in progress or planned only 2 years ago. Perceptions also influence long-run energy demand and affect the introduction of new energy technologies. If future oil prices are higher than expected and low-cost supplies smaller than currently perceived, the impact of the less energy-efficient equipment will be to advance the time when high energy prices pose a problem. The effect on the supply side will be to reduce the available options and the rate at which they can be brought on-line once prices rise.

Role of Energy in the Economy: Long-Range Perspective

Advanced industrial societies annually use energy at a rate of about 350 million Btu per capita, most of it derived from nonrenewable sources. Continuation of the historic trend would result in a tripling of per capita energy use within the next quarter to half a century. It seems unlikely that this will come to pass. Today's technological outlook, the lead time needed to introduce new technologies, and even the most optimistic assumptions about the discovery of new fossil fuel reserves cannot support such enormous consumption. However, such a future cannot be wholly ruled out, particularly should some stunning technological advances permit humankind to harness thermonuclear energy directly or via the sun. If the world's 4 billion people all consumed energy at the U.S. per capita rate, annual world consumption would be about six times the current amount.

The projections analyzed here are characterized as an extension of the trends of the recent past with the consumption and production decisions affected by relative prices and viable new technologies. Structural changes in the economy are indicated only to the extent that such changes are extensions of the recent past.

Forecast Comparisons

This review is limited to forecasts of energy supply and demand for the year 2000 that are widely circulated, sufficiently documented, and sufficiently detailed in energy and economic areas to permit comparison and assessment. A comparison of the forecast results for the year 2000 indicates basic agreement that the core sources of energy supply will be oil, natural gas and coal. There is far less agreement about the role of synthetic fuels, renewable sources, and nuclear power.

Four forecasts were selected for this review:

1. 1981 Annual Report to Congress, Volume 3,[1] Energy Information Administration, February 1982.
2. Energy Projections in the Year 2000[2] (a supplement to the National Energy Policy Plan, U.S. Department of Energy, Office of Policy, Planning, and Analysis), July 1981.
3. Data Resources Energy Review, Autumn 1982.[3]
4. Integrated Forecasting Model Synthetic Fuels Study.[4] Prepared for the Electric Power Research Institute by Decision Focus Incorporated, April 1982.

These forecasts were prepared up to a year before the publication date. Forecasts made in 1983 would be based on different assumptions, particularly with respect to the world price of oil, affecting forecasts of energy production, consumption, and the use of synthetics.

Forecast Analyses

Driving Assumptions. Input assumptions are often more important determinants of conclusions derived from forecasts than the methodologies used to produce the forecasts. In general, the most important input assumptions used in energy forecasting are economic activity (GNP), population (demographics), and future world oil prices. Assumptions for GNP and world oil prices for the studies reviewed here are presented in Table 10 below. It should be noted that the current EIA view of the future world oil price is substantially lower than those used in the above forecasts. The current Annual Energy Outlook projects the world oil price, in 1980 dollars, to be $31.63 per barrel in 1990. The world oil price in 2000 would be correspondingly lower ($50.41). The potential implications of such a revised view are discussed in the conclusions.

Assumptions regarding economic growth (Table 10) vary only slightly across the forecasts: the National Energy Policy Plan (NEPP), the 1981 Annual Report to Congress, and the Data Resource Energy Review (DRI) forecasts use a 2.5-percent per year average GNP growth rate through year 2000 as their

Table 10. Macroeconomic and World Oil Price Assumptions

	U.S. GNP Growth (percent per year from 1980)		World Oil Price (1980 dollars/barrels)	
Forecast	2000 Midrange	2000 Range	2000 Midrange	2000 Range
NEPP[a]	2.5	2.0 - 3.0	64	46 - 87
ARC[b]	2.5	--	75	50 - 100
DRI[c]	2.5	--	46	--
EPRI[d]	2.8	--	--	32 - 48
EIA	--	--	50	--

[a] U.S. Department of Energy, Office of Policy, Planning, and Analysis, *Energy Projections in the Year 2000*, DOE/PE-0029 (Washington, D.C., 1981).

[b] Energy Information Administration, 1981 *Annual Report to Congress*, Volume 3, DOE/EIA-0173(81)3 (Washington, D.C., 1982).

[c] Data Resources Incorporated, *Data Resources Energy Review*, Autumn (Cambridge, Massachusetts, 1982).

[d] Decision Focus Incorporated, *Integrated Forecasting Model Synthetic Fuels Study* (Palo Alto, California: Electric Power Research Institute, 1982).

-- = Not applicable.

Table 11. Projections of U.S. Energy Consumption for the Year 2000
(Quadrillion Btu)

Sector	1980[a]	NEPP[b]		1981 Annual Report to Congress[c]			DRI[d]
		Midrange	Range	Low	Mid	High	
Residential/Commercial							
Oil and LPG	3.3	2.2	--	1.9	1.9	2.0	1.6
Gas	7.5	7.8	--	7.2	7.0	7.4	7.2
Electricity	4.1	6.3	--	6.4	6.8	7.3	7.2
Coal	[f]0.2	0.3	--	0.2	0.2	0.2	0.3
Other	0.8	1.2	0.8 - 1.6	1.8	1.8	1.9	0.7
Total	15.9	17.8	--	17.4	17.7	18.9	17.0
Industrial							
Oil and LPG[e]	9.3	4.8	--	11.1	11.8	12.4	10.1
Gas	8.4	10.9	--	9.0	9.3	9.3	8.3
Coal	3.2	7.2	--	8.0	8.6	8.9	5.6
Electricity	[f]3.0	6.0	--	4.7	5.2	5.6	4.3
Other	1.4	2.6	2.2 - 3.1	2.4	2.5	2.4	0.1
Total	25.3	31.5	--	35.0	37.3	38.8	28.5
Transportation							
Oil	19.0	17.2	--	17.1	17.8	19.5	19.2
Gas (pipeline)	0.6	0.8	--	0.6	0.6	0.6	0.4[f]
Electricity	--	--	--	0.1	0.2	0.1	--
Alcohol	--	0.4	0.2 - 0.6	--	--	--	--
Total	19.6	18.4	17.0 - 20.0	17.8	18.6	20.3	19.6
Total End-Use Consumption ..	60.8	67.7	62.0 - 74.0	70.2	73.6	78.0	65.2

Table 11. Projections of U.S. Energy Consumption for the Year 2000 (continued)
(Quadrillion Btu)

Sector	1980[a]	NEPP[b]		1981 Annual Report to Congress[c]			DRI[d]
		Midrange	Range	Low	Mid	High	
Conversion Losses							
Synthetic	--	2.7	1.2 - 3.8	2.3	2.2	2.4	0.1
Power Generation	17.3	29.1	24.7 - 32.8	25.9	27.9	30.2	27.7
Total Losses[h]	17.3	31.8	28.0 - 36.0	28.4	30.3	32.8	27.8
Total Disposition	78.1	99.9	99.0 - 110.0	98.6	103.9	110.8	92.9
Fuels for Power Generation							
Coal	12.1	22.0	17.9 - 24.8	21.6	22.9	25.0	24.2
Oil	2.7	1.1	0.6 - 2.8	0.5	0.5	0.6	1.3
Gas	3.8	2.2	1.1 - 3.3	1.2	1.2	1.3	2.2
Nuclear	2.7	10.6	9.2 - 11.9	9.1	10.5	11.6	7.4
Other	3.2	5.5	4.7 - 6.5	4.7	4.7	4.7	4.1
Total	24.4	41.3	35.1 - 46.7	37.1	39.9	43.2	39.2
Electricity Generated	7.2	12.3	10.4 - 13.9	11.2	12.0	13.0	11.5

[a] Energy Information Administration, 1981 Annual Report to Congress, Volume 2, DOE/EIA-0173(81)/3 (Washington, D.C., 1981).

[b] U.S. Department of Energy, Office of Policy, Planning, and Analysis, Energy Projections to the Year 2000, DOE/PE-0029 (Washington, D.C., 1981).

[c] Energy Information Administration, 1981 Annual Report to Congress, Volume 3, DOE/EIA-0173(81)/3 (Washington, D.C., 1981). Low = Low GNP, Low Nuclear, Middle World Oil Price; Middle = Middle GNP, Middle Nuclear, Middle World Oil Price; High = High GNP, High Nuclear, Middle World Oil Price.

[d] Data Resource, Inc., Energy Review, Autumn (Cambridge, Massachusetts, 1982).

[e] Includes asphalt.

[f] Energy Information Administration, Estimates of Wood Energy Consumption from 1949 to 1981, DOE/EIA-0341 (Washington, D.C., 1982).

[g] Less than 0.05 quadrillion Btu.

[h] Includes unaccounted gas losses.

-- = Not applicable.

base values and the Electric Power Research Institute (EPRI) uses 2.8 percent per year.

Energy Demand. The NEPP, Annual Report, and DRI forecasts, shown in Table 11, envision a similar future for residential/commercial energy as well as a shift away from oil and toward electricity. The EPRI forecast is excluded from this table because demand detail is lacking in the documentation. In the aggregate, the forecasts differ by less than 2 quadrillion Btu; the DRI forecast is at the low end, but DRI's low value is likely due to the exclusion of items included in the "other" category in the Annual Report and NEPP forecasts.

The forecasts are also consistent regarding transportation demand; all show stability or a slight decline in energy use for this sector. As with the residential/commercial sector, differences among the forecasts are limited to about 2 quadrillion Btu.

The industrial sector forecasts show the greatest diversity. The Annual Report shows a range of 35 to 38.8 quadrillion Btu, the NEPP is somewhat lower, and DRI shows only 28.5 quadrillion Btu by year 2000. Both the NEPP and Annual Report show higher growth of electricity and the direct use of coal in the industrial sector than does DRI. The Annual Report shows a slight growth from 1980 in the use of oil and LPG, while the NEPP envisions a reduction by 2000 to less than 50 percent of the 1980 level. It should be noted that this figure is lower than feedstock use for the chemicals and allied products industries in 1979. All the forecasts considered here show slight increases by the year 2000 from 1980 levels for natural gas use; forecasts for "other" fuels are consistent except DRI.

Energy Supply

Differences in the projected mix of energy supply are more pronounced than differences in demand. Although there is broad agreement on the continued role of domestic oil, natural gas, and coal, there are major differences on the future roles of synthetics, nuclear power, renewables, and oil imports (see Table 12). Renewables are those energy resources that either replenish themselves naturally, such as wood, wind, hydroelectric power, and biomass, or that have a long geologic time horizon such as geothermal and solar energy.

Conventional Fuel Supply. All forecasts except NEPP show moderate declines in domestic oil, natural gas liquids, and natural gas production. All forecasts show coal production approximately doubling from 1980 to 2000.

All forecasts show a decline in conventional oil production from the Lower-48 States, and stability or slight increases in supply from enhanced oil recovery and Alaska. The major differences are in synthetics and total liquid fuel supply; forecasts with lower synthetics projections and/or higher requirements for liquid fuel supply have higher oil imports.

Table 12. U.S. Energy Production and Net Imports for the Year 2000
(Quadrillion Btu)

Sector	1980[d]	NEPP[a]		ARC[b]			DRI[e]	EPRI[c]	
		Midrange	Range	Low	Mid	High		YYY	NNN
Oil and NGL	20.5	17.5	14.0 - 23.2	19.8	19.8	19.8	17.4	15.9	17.1
Synthetic Liquids									
Shale[f]	--	2.3	1.3 - 3.4	1.7	1.7	1.7	0.	1.6	0.1
Coal-derived[f]	--	2.3	1.3 - 3.6	1.5	1.5	1.5	0.3	8.1	2.0
Biomass[f]	--	--	--	0.8	0.8	0.8	--	--	--
Synthetic Gas[f]	--	1.4	1.0 - 2.0	0.1	0.1	0.2	0.4	3.9	0.5
Natural Gas	20.1	18.0	14.7 - 21.4	17.3	17.6	17.6	15.5	18.3	17.7
Coal	19.2	41.7	37.1 - 45.9	38.5	40.5	43.0	35.9	51.4	38.5
Nuclear	2.7	10.6	7.4 - 14.0	9.1	10.5	11.6	7.4	3.9	3.9
Renewables	[g]5.2	9.7	7.6 - 11.9	10.5	10.6	10.8	4.2	--	--
Total Domestic Production	67.7	99.8	83.0 -116.0	96.9	100.7	104.5	80.9	--	--
Net Imports									
Oil	13.5	2.5	0.0 - 11.0	6.8	8.3	10.8	14.1	7.4	13.9
Gas	1.0	2.0	1.0 - 3.1	0.5	0.6	1.1	2.8	1.5	1.1
Coal and Hydro	-2.2	-5.9	-3.4 - -8.4	-5.6	-5.6	-5.6	-4.8	--	--
Total Net Imports	12.3	0.0	NA	1.7	3.3	6.3	12.1	--	--
Adjustments	-1.9	--	--	NA	NA	NA	--	--	--
Total Domestic Supply	78.1	100.0	90.0 -110.0	98.6	104.0	110.8	92.9	--	--

Table 12. U.S. Energy Production and Net Imports for the Year 2000 (continued)
(Quadrillion Btu)

Sector	1980[1]	NEPP		ARC			DRI	EPRI	
		Midrange	Range	Low	Mid	High		YYY	NNN
Conventional Oil									
Lower-48 States	14.8	8.9	7.2 - 12.7	11.7*	11.7*	11.7*	9.5	15.9	17.1
Alaska	3.4	3.8	3.0 - 4.2	4.5*	4.5*	4.5*	3.1		
Natural Gas Liquids	2.2	1.0	1.3 - 1.7	*	*	*	1.2		
Enhanced Oil Recovery	**	3.8	3.0 - 5.1	3.6	3.6	3.6	3.6		
Shale Oil	-	2.3	1.3 - 3.4	1.7	1.7	1.7	0.5	1.6	0.1
Synthetics									
Coal Liquids	-	2.3	1.3 - 3.6	1.5	1.5	1.5	0.3	8.1	2.0
Liquids from Biomass	-	-	-	0.8	0.8	0.8	-	-	-
Total Domestic Production .	20.5	22.2	19.5 - 26.6	23.8	23.8	23.8	18.2	25.7	19.2
Net Oil Imports	13.5	2.5	0.0 - 11.0	6.8	8.3	10.8	14.1	7.4	13.9
Total Liquid Supplies	34.0	24.7	24.0 - 28.0	30.6	32.0	34.5	32.4	33.1	33.1

*Conventional oil and natural gas liquids are combined.

**Included in conventional oil.

Note: Totals may not add due to rounding and/or fuel conversion factors us

[a] U.S. Department of Energy, Office of Policy, Planning, and Analysis, Energy Projections to the Year 2000, DOE/PE-0029 (Washington, D.C., 1982).

[b] Energy Information Administration, 1981 Annual Report to Congress, Volume 3, DOE/EIA-0173/81)3 (Washington, D.C., 1982).

[c] Decision Focus Incorporated, Integrated Forecasting Model Synthetic Fuels Study, Volume I, Overview and Findings, (Palo Alto, California: Electric Power Research Institute, 1982).

[d] Energy Information Administration, 1981 Annual Report to Congress, Volume 2, DOE/EIA-0173(81)2 Washington, D.C., 1982).

[e] Data Resource Incorporated, Data Resources Energy Review, Autumn (Cambridge, Massachusetts, 1982).

[f] These categories are shown for informational purposes, but are not included in the total. Fuels used by these processes are already included in the other fuel categories. Low and medium Btu coal gas is not included in this category for the Annual Report forecast but is for the other forecasts.

[g] Adjusted to include biomass.

-- = Not applicable.

NA = Not available.

Note: Totals may not sum because of rounding and/or fuel conversion factors used.

Synthetic Fuels. All forecasts project some role for synthetic fuels by the year 2000. However, the size of the role seems conditioned by recent events; the more recent the forecasts, the less optimistic the future role of the Synthetic Fuels Corporation and the less optimistic the outlook for synthetics. The NEPP (July 1981) midrange case projects 6 quadrillion Btu by 2000, the Annual Report (February 1982) projects approximately 4 quadrillion Btu, and DRI (Autumn 1982) only 1.2 quadrillion Btu. The EPRI forecast (April 1982), which focused on synthetics, shows 2.7 quadrillion Btu for its least favorable synfuels scenario and 13.6 quadrillion Btu for its most optimistic projection. All forecasts show synthetic liquids playing a far larger role than synthetic gas. Liquids from coal and shale are roughly equal in all forecasts but EPRI's; EPRI projects that coal liquids will be significantly more important than liquids from shale.

Lower projections of synfuels production across the NEPP, Annual Report, and DRI forecasts are consistent with the perceptions of lower future world oil prices associated with each forecast. The more bullish EPRI forecasts must be attributed to assumptions regarding future coal prices and differences in forecast methodology. Resource supply curves for coal in the Integrated Forecasting Model (IFM) used in producing the EPRI forecasts show extensive additions to reserves available at $1 per million Btu or less, implying no real increases in the cost of coal over a long-term horizon.

Nuclear Power. NEPP and Annual Report project about 10 quadrillion Btu of nuclear power by 2000 versus 2.7 in 1980. DRI projects 7.4 quadrillion Btu, and EPRI only 3.9 quadrillion Btu. Given that existing plants and those currently under construction can provide about 7.3 quadrillion Btu, and that no new plants have been ordered since 1978, the higher forecasts imply that a strong resurgence of the industry may occur in the longer term.

Renewables. As with nuclear, NEPP and Annual Report are more optimistic about the contribution of renewables than DRI (although DRI does show a substantial increase for year 2000 above 1980 levels). Renewables are more competitive in the DOE scenarios with higher oil price paths.

All forecasts show a modest increase in the contribution from hydroelectric power by the year 2000, and a substantial increase in the contribution from other renewable sources. The Annual Report is more optimistic about the future of geothermal and biomass than the other forecasts, while NEPP is more bullish on the future of wind and wave power. The two DOE forecasts are not in broad agreement regarding the future of renewables, while DRI appears considerably more conservative. The DRI forecast does not differentiate among renewable energy sources and does not seem to include biomass. In view of the lower expected future world oil price path and the relatively high capital cost of many renewable technologies, future use of renewable energy resources would probably now be forecast to be lower than either the 1981 Annual Report or NEPP.

Table 13. Energy and Economic Growth

History and Forecast	Primary Energy Quadrillion Btu)[a]	Real GNP (Billions of 1972$)[b]	Energy/GNP Ratio (1,000 Btu/1972$)[c]
1960	44	737	59.7
1965	53	929	57.1
1970	67	1,086	61.7
1975	71	1,232	59.5
1980	76	1,474	51.5
1981	74	1,503	49.3
AEO82[d]			
1990	88	1,826	48.2
NEPP[d]			
1990	88	1,950	44.6
2000	100	2,420	41.3
ABC[d]			
1990	89	1,953	45.6
2000	104	2,433	42.7
DRI[d]			
1990	82	1,919	42.7
2000	93	2,445	38.0

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[a] The figures do not include wood usage in the nonutility applications (about 2.2 quadrillion Btu, 1980). Wood usage is included for all forecast years with about 3 quadrillion Btu in the Annual Energy Outlook forecasts for 1990. Also, see the Energy Information Administration Annual Report to Congress, 1982, p. 7.

[b] Economic Report of the President, Council of Economic Advisors, (Washington, D.C., 1983) p. 234.

[c] Computed from previous two columns.

[d] These represent the "base" or "midprice" cases.

Table 14. Reductions in the Energy/GNP Ratios
(Percent Reduction)

Forecast	1970-1990	1980-2000
ARC81	26.1	16.4
AEO82	21.9	--
NEPP	27.7	19.2
DRI	30.1	25.6

Note: For historical data, 1960-1980, the energy/GNP ratio declined 14.4 percent of total.

-- = Not applicable.

Imports and Exports. All forecasts show a substantial increase in coal exports by the year 2000, and from 1 to 3 quadrillion Btu of natural gas imports. Although projecting the lowest overall energy demand, DRI projects the highest oil imports (14.1 quadrillion Btu, approximately 7 million barrels per day) for the year 2000. This is due to lower projections of supply from domestic sources in all areas, but especially nuclear and synthetic fuels. Both the Annual Report and NEPP show a broad range of imports for various scenarios, but none as high as DRI. The midrange case for NEPP has only 2.5 quadrillion Btu of oil imports, and the Annual Report has 8.3 quadrillion Btu.

Energy-GNP Ratios

A common measure of the aggregate efficiency of energy use in the economy is provided by the ratio of primary energy consumption to the constant dollar value of total final output (i.e., the GNP). While fluctuating in the short run, there has been a general downward trend in this measure over the last 20 years (see Table 13). This has occurred even though delivered energy prices were declining for much of this period in real terms. With rising real energy prices, the energy intensity of the economy should continue to decline.

The ratio has declined 14.4 percent in the 21-year period from 1960 to 1980. Most of this change occurred in the second half of the 1970's, at least as a partial response to the rapid price escalation of the 1970's. Since NEPP, 1981 Annual Report, and the DRI forecasts all assume a real 2.5 percent/year growth, differences in energy use for the 1980 to 2000 period must be attributed to differences in the economic and technological structure of the economy.

All of the forecasts indicate an acceleration in the decline of the ratio for the period 1970 to 1990, with DRI showing a 30.1 percent decline from 1970 and this year's Annual Energy Outlook showing the smallest decline, 21.9 percent (see Table 14). The reductions for the 1980 to 2000 forecast period range from 16.4 percent in the 1981 Annual Report to 25.6 percent (DRI). The 1981 Annual Report forecast clearly assumes a continuation of recent historical declines of the energy GNP ratio and a continuation of the economic trends of the past 20 years. DRI, however, seems to be implying accelerated structural changes in the economy, away from energy-intensive industries and towards communications and services.[5]

Synthetic Fuels

History

Synthetic fuels (liquids or gas produced from coal, oil shale, or tar sands) have been produced in commercial quantities sporadically since the mid-1800's. Kerosene for illumination was produced from shale oil in the American West until driven out by inexpensive petroleum. The gas street lights still in use in some eastern cities are reminders that before the coming of the electric light, gas from coal-brightened streets (each municipality had its own "gasworks").

The deposits of solid fossil energy sources are enormous--shale alone in the western United States is estimated to hold the equivalent of 1,800 billion barrels of proven reserves. Periodically, interest in establishing a synthetic fuel industry has been aroused when it seemed that demand for liquid fuels would outstrip supplies. In each instance, abundant petroleum became available at prices below those required for economic viability of synthetic fuels production. Outside the United States, liquid fuels from coal have been produced only when economics have been secondary to the security of the supply (in Germany before and during World War II, and in South Africa since the 1950's). Production of liquids from the rich Athabasca tar sands of Canada and from oil shale in Brazil have proceeded only with significant government encouragement.

The German war effort produced 100,000 barrels per day at its peak in 1944; South Africa's program will reach this level in the mid-1980's. The new South African facilities (Sasol II and III), with capacities of 50,000 barrels per day, are the largest yet constructed. Costs of liquid fuels from these plants are estimated at $50 to $80 per barrel; costs in the United States would be higher due to stricter environmental control requirements and higher labor costs.

When the United States Government announced its intention to stimulate development of a synthetic fuels industry following the OPEC embargo in 1973, there was a surge of interest by private industry. This interest has all but disappeared as former perceptions of continually increasing oil prices have been reversed by lower prices associated with the current "oil glut." The original goals of the Synthetic Fuels Production Act of 1980 (500,000 barrels per day of oil equivalent by 1987, 2 million barrels per day by 1992) have become unrealistic in a very short time.

Uncertainty Regarding Technological Viability

Cost. Although no one knows what the actual cost of production for synthetic fuels in the United States will be until a commercial-scale facility is constructed and operated, recent experience with development and demonstration has reduced the technical uncertainties, increased the confidence, and reduced the range of engineering cost estimates.[6] In spite of improvements in the quality of cost estimates, enough uncertainty remains to affect the course of major projects; the stated reason for Exxon's withdrawal from the Colony oil shale project was cost escalation during detailed design.[7]

One uncertainty that could increase costs, as with nuclear power plants, is an increase in the time required to bring a plant into production from the start of construction. With the high interest rates prevailing in the late 1970's, interest during construction can account for a third of a plant's capital cost. The possibility of legal intervention during plant construction carries with it the prospect of increased costs associated with delays.

Environment. The environmental effects of a synthetic fuels industry range from the disturbance of land through mining to the poisoning of water tables through potentially carcinogenic compounds in the fuel byproducts. However, environmental problems are not expected to be a limiting factor, at least during the early stages of industry development. Synthetic fuels production may be compared to petroleum refining or electric power generation; while not totally environmentally benign, effects of these industries appear manageable at reasonable cost with existing technology.

Water Availability. Water availability is an issue in arid sections of the West if the vast oil shale and low-cost coal resources of the West are developed. Synthetic fuels production required 2 to 4 barrels of water per barrel of oil, but a well financed synthetic fuels industry could likely bid water away from agricultural interests. Several studies[8] indicate that sufficient water could be made available to support substantial synthetic fuels production in the West without displacement of agriculture. Water availability is not in general a problem for facilities in the East.

Government Involvement. The first United States Government involvement in synthetic fuels development came with the Synthetic Liquid Fuels Act of 1944 and supported development of methods for large-scale shale oil production by the U.S. Bureau of Mines at Anvil Points, Colorado. The Energy Research and Development Administration, and later the Department of Energy, supported research, development, and demonstration of synthetic fuels technology throughout the 1970's. The Energy Security Act of 1980 established the U.S. Synthetic Fuels Corporation (SFC). The goal of the SFC was to establish the industry by working as an investment bank, offering loan guarantees, price guarantees, purchase agreements, loans, and joint ventures to private industry; Congress appropriated approximately $20 billion for this purpose. Only two of the 61 projects entered in the first phase of the SFC's solicitations were advanced into negotiations for possible financial assistance by June of 1982: the Hampshire and Breckenridge coal liquids projects. By the end of November 1982, the major sponsors of both projects (Standard Oil of Ohio and Ashland Oil, respectively) had withdrawn from participation.

Prior to the activation of the SFC, The American Natural Resources' Coal Gasification Project (North Dakota) received $2 billion in loan guarantees from the Department of Energy, and Union Oil was awarded $400 million in price guarantees for its oil shale project (Colorado). Tosco, with a 40 percent interest in the Colony oil shale project, had also received aid (which will be refunded to the Government now that the project has been cancelled).

National Security. The current view of the majority of energy analysts is that one of the objectives of a synfuels industry--reduced threat of economic disruption from oil supply interruptions--can be more effectively addressed via other options (particularly stockpiling). Two other goals--improving the balance of payments and increasing national security by reducing dependence upon imported oil--may be achieved more economically through demand reductions and stimulation of alternative domestic supplies. Nevertheless, the goal of national security may be furthered by the existence of a synfuels industry that would provide additional liquid fuels.

Outlook

The optimism that surrounded the creation of the SFC in 1980 has rapidly given way to disenchantment in the face of rising project costs and falling oil prices. In the current environment, even with Government assistance, the private sector cannot justify major investments in synthetic fuels facilities.

Yet, several U.S. projects are moving ahead--most notably the American Natural Resources coal gasification and Union Oil shale oil projects--and these will add to the technology information base required for the ultimate development of a mature industry. Active projects in other countries, including Germany, New Zealand, and South Africa, will also contribute to the state of knowledge. Although at the present pace of development, synfuels will contribute little in the short run to the goals of the Energy Security Act--to "improve the nation's balance of payments, reduce the threat of economic disruption from oil supply interruptions, and increase the nation's security by reducing dependence upon imported oil." The long-term potential contribution of synfuels from oil shale, coal, and tar sands remains enormous.

Electric Utility Energy Outlook

Long-Term Electric Utility Outlook

The price of world oil has only an indirect effect on the end-use demand for electricity. Accordingly, prospects for electric power generation in the long term depend on broad economic, social, and environmental factors and on the continued availability of conventional energy resources used in generation. These include, coal, oil, natural gas, and uranium supplies besides hydroelectric power and wind generation. In addition, alternative technological approaches designed to reduce the consumption of oil and natural gas will probably utilize a combination of previously unused but existing technologies or use other resources like the sun, the wind, geothermal, and biomass that are characterized by unrestricted availability or by natural renewability.

Notwithstanding the potential for new developments in the future, electric power generation in 2000 will probably be dominated by prevailing conventional production methods. Accordingly, coal-, oil-, gas- and nuclear-powered generating plants, with significant contributions from hydroelectricity, will continue to provide the major share of needed capacity. Among the potential technologies that currently hold the promise of being adopted by the year 2000 are: atmospheric fluidized bed boilers fired by coal, low-Btu gas combined cycle, fuel cell supplied either by coal gasifier or by oil, fast breeder reactors, and some renewable technologies. The latter category includes biomass and wind. Other, somewhat less mature technologies like magnetohydrodynamics and ocean thermal electricity, though not likely to contribute significantly by year 2000, may make substantial energy contributions at approximately the same time as magnetic fusion. The extent of penetration of these new technologies would, however, hinge on the interaction of market forces to determine their economic feasibility for commercialization and their functional role in providing either baseload or peaking power on a cost-effective basis. Given the various uncertainties that inevitably govern the implementation of any new technology or resource, the electric utility industry will probably continue to rely on coal and nuclear fuels and attempt to minimize, to the extent possible, the use of oil and natural gas in the future. Even here, interfuel generation choices will be conditioned by the usual cost benefit considerations, adaptability to siting restrictions, and compliance with prevailing environmental requirements.

Regional limitations on the mining and transportation of large quantities of coal and air quality standards might result in higher coal costs and lower growth rates of coal use than currently envisaged. Fuel-specific aspects of the outlook for nuclear power involve questions of the extent of the domestic uranium resource base and the efficiency of current and potential nuclear technologies. In addition, the safety, environmental, and nonproliferation issues associated with nuclear technologies are of increasing domestic and international concern. Finally, the social acceptability of nuclear power in the light of the Three Mile Island accident remains difficult to assess and quantify objectively. In view of these uncertainties, renewable and/or other resources like the sun and the wind might possibly play a greater than anticipated role. These developments will come only gradually and over an extended time horizon well into the next century.

Factors in the Long-Term Development of Electric Power

The various projections used in this chapter show an increasing demand for electricity, but at rates significantly lower than those of the earlier projections. As a result, only gradual changes in the overall composition of the national generating system are likely to occur by the year 2000. However, the potential for rather radical (although less likely) changes during the long term also exists. For example, there could be a significant lifestyle change which leads to an increase in the use of small, dispersed cogenerating systems that might provide both heat and electricity to local areas more efficiently.

Such an increase may stimulate additional requirements for coal systems, such as fluidized-bed combustion boilers and coal gasifier-combined cycle systems. These technologies are expected to be suited to small scale operations (50 to 300 megawatt), and might be used locally, satisfying the environmental need to control noxious emissions. Nuclear power systems, however, may be noncompetitive in the local settings, owing to the very high cost of constructing small reactor plants (less than 600 megawatt) reactor plants and the severe criteria for reactor siting.

It is also possible that factors of water competition, site geology, and population density may reduce the number of nuclear sites likely to be available in the future. This situation has been intensified by the Three Mile Island accident, which revealed the need for improved civil preparedness and evacuation procedures during a nuclear emergency. These added uncertainties and stringent siting restrictions may imply that future reactors may be located primarily on existing nuclear sites. These considerations would, however, apply to new construction projects rather than those already in the pipeline.

Capacity expansion forecasts for the electric utility sector for the long-term project continued dependence on coal-fired and nuclear units. Over 80 percent of total domestic electric supply will probably come from coal and uranium in the year 2000 with oil and natural gas used mainly to provide peak demand. Coal and nuclear power generation provided 66.5 percent of the total power generated in the United States in 1982. The contribution of oil, natural gas, hydroelectric power, geothermal heat, biomass, wind, solar energy, and other new technologies are expected to provide the remainder. Of this, solar and other production possibilities may provide up to 2 percent of the total in the year 2000.

Nuclear Energy in the Longer Term

A long-term resurgence in new nuclear power orders is possible under the following conditions:

- The need for new electric generating capacity clearly increases.
- Nuclear power remains competitive with alternative generation sources, such as coal.
- Utility financial practices and utility rate structures are modified to reduce debt equity and cash-flow burdens of new nuclear construction.
- Uncertainties surrounding nuclear generating plants are resolved, including the predictability of the nuclear licensing process, nuclear safety regulations, reactor siting, and long-term uranium availability.
- The nuclear waste disposal problem is resolved, particularly the construction of a Federal repository for the long-term disposition of highly radioactive wastes.

Table 15. Nuclear Power Capacity Projections Through 2000 (Gigawatts of Net Electrical Capacity)[a]

Year Nuclear Case	Low Nuclear Case[b]	Middle Nuclear Case	High
1982	60	60	60
1985	72	80	90
1990	112	114	121
1995	113	122	127
2000	110	130	140

[a] Capacity estimates are rounded at yearend. Middle and high nuclear cases beyond the year 2000 are based on the respective year--2000 capacities adjusted by the long-term growth rates for nuclear capacity from Table 28 of the EIA 1981 Annual Report to Congress, Volume 3, DOE/EIA-0173(81)/3 (Washington, D.C., February 1982), p. 110.

[b] The low nuclear sensitivity assumes a lower GNP and electricity demand growth than the middle case and a reactor addition rate sufficient to replace retirements only.

A major concern among various industry segments is that a long delay in attaining these conditions would result in the dissolution of the industry infrastructure and the dispersal of the highly skilled technical staff to other areas of the economy. All but one domestic vendor have turned their corporate resources to nuclear fuel services and plant maintenance rather than outright promotion of new nuclear reactor sales.

In view of the continued attrition in demand growth, utility financial constraints and the 18 nuclear power plant cancellations experienced in 1982, the longer term nuclear power projections of EIA's 1981 Annual Report to Congress have been reassessed and are presented in Table 15. Nuclear capacity could reach 130 gigawatts (GWs) by the year 2000.

Although there is no specific accounting in this reassessment for advanced nuclear technologies, two such technologies are potential new sources of power in the longer term. The first, the liquid metal fast breeder reactor is currently in the development stage in the United States and is designed to extract more energy from uranium than current reactors. The breeder reactor is not generally projected to become economically competitive with conventional nuclear technology until well into the 21st century because the cost of uranium is projected to remain relatively low.

A potential alternative, magnetic fusion energy, is technically less-developed than the fast-breeder reactor, but it could offer a potentially safer, more abundant resource for future electricity generation. The process requires the fusion of heavy hydrogen nuclei, under great temperatures, to form helium. The central problem is the maintenance of a large-scale, sustained, and controlled fusion reaction. Fusion technology is not likely to contribute significantly to electricity generation until well into the next century. These results are highly conditioned on the timing of necessary technological innovations and other economic and institutional factors, all of which are highly uncertain.

The long-term projections reviewed earlier in this chapter imply that electricity demand will continue to increase, albeit at lower levels, corresponding to lower expectations for growth relative to growth in the general economy. Coal-fired and nuclear powered technologies could serve the major portion of future demand for electricity barring unforeseen constraints. A total phase-out of fission, over the long term, however, if replaced by coal-fired generation, may lead to untenable levels of coal utilization. On the other hand, if new coal generation technologies are more expensive than currently estimated, nuclear power could contribute even more significantly if a plentiful and reasonably priced supply of uranium continues to be available and if the nuclear power infrastructure still exists in the late 1980's to meet the anticipated increase in demand for reactor systems.

Financial Constraints

Projected developments for the electric utility industry in the long term depend on the availability of financial capital to undertake new investment activity in plant, equipment, and related infrastructure. Since the early 1970's, investor-owned utilities have encountered difficulty in financing new investments. A decline in demand growth to lower-than-historical averages compounded the problem by causing a decline in total utility revenues. In consequence, the residual profits of the utilities were significantly squeezed. Accordingly, many utilities have postponed or canceled construction of planned capacity additions.

Although the financial results of the utilities have improved dramatically during the last 2 years, 1981 and 1982, there is still cause for continuing concern. If the utilities face no financial constraints, they could be expected to build capacity additions commensurate with economic growth and the resulting growth of demand for power. It would also be reasonable to assume that uneconomic generating capacity would also be retired and fuel conversions would proceed as planned. If, on the other hand, utilities cannot obtain financing readily (due to inadequate earnings), they will not be able to replace uneconomic existing generating capacity to nearly the same degree and may be forced to keep the older plants in service longer. Some cutback in new construction activity would also be inevitable. Both these developments, while undesirable from the viewpoint of its impact on the economy, will also result in raising the long-term price of delivered power.

System reliability may be ensured by building additional combustion turbines that are also more expensive to operate than coal or nuclear. Given the long lead times necessary for new coal-fired plants (7 to 9 years) and nuclear plants (11 to 13 years), potential delays and/or cancellations might well imply that the most economically efficient capacity may not be available to meet demand.[9]

Footnotes to Chapter 4

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2. Energy Information Adminstration, Energy Projections to the Year 2000 (Washington, D.C., 1981).

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4. Electric Power Research Institute, Integrated Forecasting Model Synthetic Fuels Study (Palo Alto, California, 1982).

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6. Electric Power Research Institute, Integrated Forecasting Model Synthetic Fuels Study, Volume 1, (Palo Alto, California, 1982), pp. 1-19.

7. Jennrich, John H., "Uncertainty, Cost/Price Squeeze Hit Fledgling Synfuels Industry," Oil and Gas Journal (May 24, 1982), p. 24.

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9. Energy Information Administration, Impacts of Financial Constraints on the Electric Utility Industry, (Washington, D.C., 1981).

Appendix A
Base Case and Sensitivity Case Reports

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This appendix presents a guide to the key tables which briefly summarize the contents of each table. A location guide to the specific data in each table is then given. The specific data include: historical and projected values for energy prices, quantities, macroeconomic information, and measures of energy efficiency. Then the selected output reports for the three world oil price cases and the five sensitivity cases are provided. The same set of tables has been included for the base case and the world oil price sensitivity cases but the five other sensitivity cases contain the executive summary tables, Table 1.1 thru 1.6, and the appropriate tables to illustrate the impact of the sensitivity assumptions.

A complete listing of the output reports for each case can be found in the supplement to the Annual Energy Outlook.

Guide to Key Tables

In each section of scenario tables, the same numbering sequence has been adopted. In most cases, to minimize the size of this volume, not all of the tables have been provided. Although the tables are numbered A.1.1 to H.8.1, they are described generically below as 1.1 to 8.1.

This appendix contains the tables that form the basis for the projections for the midprice case. The tables are preceded by a short description of the key entries in each table and a guide that indicates where specific pieces of information can be found. Finally, there is a summary of the key changes for several sensitivity analyses.

Tables 1.1 to 1.4 provide national summaries of energy supply, demand, and prices. Quantities are in quadrillion Btu per year and prices are in 1982 dollars per million Btu. In general, these tables present the basic energy balance but only summarize the detail found in the subsequent fuel or sector specific tables. Table 1.1 and Table 1.2 aggregate the results described at the sector/fuel level in Table 1.3. Table 1.4 provides the corresponding sector/fuel prices. Basic consumption forecasts by sector are provided in Table 4, and the electric utilities summaries can be found in Table 5. Fuel specific balances for oil, gas, and coal can be found in Tables 6.1, 7.1, and 8.1, respectively.

Table 1.1 - Supply/Disposition of Total Energy

This is the key balance table designed to be consistent with Table 2 of the Short-term Energy Outlook, February 1983. It provides:

- Domestic production by fuel type
- Imports (exports) by fuel type
- Nonutility consumption by fuel type (expanded in Table 1.3)
- Utility fuel inputs by fuel type (expanded in Table 1.3)
- Total energy supply and disposition.

Table 1.2 - Supply/Demand Balance

This table emphasizes sectoral contributions but is otherwise identical to Table 1.1. It provides:

- Domestic supply by fuel type
- Imports by fuel type
- Consumption by end-use sector
- Adjustments such as losses, exports, or stock changes
- Electric utility fuel consumption by fuel type
- Electricity generation
- Total supply, end-use consumption, and disposition.

Table 1.3 - Consumption Summary

This table provides a detailed backup to Tables 1.1 and 1.2. It describes fuel consumption by sector, but does not include losses, such as those which occur in refineries, or electricity generation and transmission. These losses are shown in Table 1.1 and 1.2.

Table 1.4 - Price Summary

This table provides the sectoral composition of prices associated with Table 1.3. It includes:

- World oil price
- Prices by end-use sector and fuel.

Supply prices are found in sections 6, 7, and 8.

Tables 2.1 to 2.4 provide summaries of various international economic and energy indicators.

Table 2.1 - Real Gross Domestic Product Annual Average Compound Growth Rates

This table provides annual average compound percentage growth rates of real gross domestic product for groups of countries in the Organization for Economic Cooperation and Development (OECD), for non-OECD countries, and for free world countries for the periods 1960 to 1973, 1973 to 1980, and projections for 1980 to 1990.

Table 2.2 - Alternate OPEC Production Capacities, 1981-1990

This table provides the production for each Organization of Petroleum Exporting Country (OPEC) for 1981 and projections of low and high production capacities for each OPEC country for 1985 and 1990.

Table 2.3 - Free World Oil Consumption and Production

This table provides world petroleum prices, consumption, and production for historical years 1960, 1973, and 1981 and high, medium, and low price projections for 1985 and 1990. It includes:

- World oil price in 1982 dollars
- Consumption for several countries or groups of countries
- Production for several countries or groups of countries.

Table 2.4 - World Oil Prices Sensitivity Analysis

This table provides sensitivity ranges for world oil price projections under a variety of scenarios for 1985, 1990, and 2000.

Table 3.1 - National Macroeconomic Indicators

Table 3.1 provides key macroeconomic variables. These include:

- Real growth rate
- Inflation rate
- Unemployment rate
- Population (in millions)
- Per capital real disposable income (1979 dollars)
- Federal Reserve Production Index (1976 base).

The projections in the table represent outputs of the macroeconomic model in the Integrated Future Forecasting System. They are not the input macroeconomic assumptions, but differ slightly from these due principally to calibration errors between the model and the Data Resources Incorporated quarterly projection, TRENDLONG 0283. Changes in the table between different scenarios represent an assessment of the economic impacts of the energy changes. However, differences between this and the input assumptions mainly reflect calibration errors.

Tables 4.1 to 4.4 provide detailed consumption summaries for the residential, commercial, industrial, and transportation sectors, respectively. Note that the residential and industrial tables describe fuel use in trillions of Btu per year, whereas the commercial and transportation tables give fuel consumption in quadrillion Btu per year. The results of these tables are summarized in Table 1.3 and 1.4.

Table 4.1 - Residential Consumption by End-Use Service

- Space heating
- Water heating
- Air conditioning
- Other end uses: includes lighting, cooking, refrigeration, washing, drying.

Table 4.2 - Commercial Consumption and Floorspace by Building Category

- Warehouses: agricultural, refrigeration, nonrefrigeration, storage
- Institutions: jails, hospitals
- Offices: laboratories, outpatient clinics, educational buildings
- Hotel/motel
- Retail/wholesale
- Miscellaneous: religious facilities, assembly halls, parking garages, recreational facilities.

Table 4.3 - Industrial Energy Consumption

- Coal: steam and metallurgical
- Oil products: distillate, residual fuel, liquid petroleum gas, petrochemical feedstocks, other
- Natural gas: includes feedstocks
- Other: includes asphalt, petroleum coke, lubricants, industrial kerosene, waxes, miscellaneous petroleum products.

Table 4.4 - Transportation Sector Energy Consumption

- Fuel use: gasoline, distillate, jet fuel, residual fuel, liquid gas
- Light duty vehicles: sales, vehicle miles, fuel efficiency, fuel use
- Heavy trucks: sales, vehicles miles, fleet efficiency, fuel use
- Air travel: revenue passenger miles, load factor, fuel use.

Tables 5.1 to 5.5 are the electric utilities summaries. Projections include fuel prices, fuel consumption, sectoral and U.S. electricity prices and demands, available capacity, generation provided by capacity type, and components of electricity price. Fuel prices are 1982 dollars per million Btu, while electricity components of price are in 1982 dollars per thousand kilowatt-hours per year. Capacity projections are in gigawatts. In addition, Table 5.4 contains a list of scheduled capacity additions for each year, in megawatts.

Table 5.1 - Electric utility fuel prices and consumption

- Fuel prices: coal, natural gas, distillate, high and low sulfur residual fuel, uranium
- Fuel inputs by plant type: coal, natural gas, distillate, high and low sulfur residual fuel, nuclear power, hydroelectric power.

Table 5.2 - Electricity Prices and Demands

- Sectoral prices: residential, commercial, industrial, transportation
- Average U.S. price
- Sectoral electricity demands
- Total U.S. demand.

Table 5.3 - Capacity

- Available capacity by plant type (gigawatts)
- Generation produced by plant type (billion kilowatt-hours per year)
- Canadian imports (billion kilowatt-hours per year).

Table 5.4 - Scheduled Capacity Additions

- Utility plants presently under construction or possessing a construction permit (megawatts)
- Represents input data not projections.

Table 5.5 - Summary of Components of Electricity Price

- Components include capital, fuel, operating and maintenance (O&M), and other (depreciation and taxes)
- Price components for private utilities and all utilities.

Table 6.1 - Annual Supply and Disposition of Petroleum

Table 6.1 is the petroleum supply and demand summary equivalent to Table 5 in the Short-term Energy Outlook February 1983. It provides:

- Production: crude oil, natural gas liquids, other
- Imports: crude oil, refined products
- Imports include acquisitions for Strategic Petroleum Reserve (SPR)
- Exports: crude oil, refined products
- Stock changes (exclude SPR stock changes)
- Products supplied: motor gasoline, distillate, residual, fuel oil, other.

Table 7.1 - Natural Gas Supply/Demand Balance

Table 7.1 is the natural gas supply and demand summary. It includes:

- Domestic supply: lower-48 onshore and offshore
- Imports (dry gas plus liquified natural gas)
- Supplemental gas: synthetic gas or increased gas imports
- Supply and prices by category: new, old interstate, old intrastate, and deep gas
- Consumption and delivered prices by sector: residential, commercial, refinery, utilities, industrial
- Losses: lease and plant fuel, gas used in pipelines.

Table 8.1 - Coal Production by Type

Table 8.1 presents the coal production projections in million of short tons year.

- Domestic supply by region: Eastern, Western
- Other supply sources: Net Imports and Stock Withdrawals (for 1980 only)
- Consumption by end-use sectors including synthetic use.

Location of Key Solution Values

Outlined below is a topical reference guide for the tables contained in this appendix. It indicates where to find specific topics including supply, demand, and prices of primary fuels and products. A "P" in parentheses indicates projections are in physical units, while a "S" denotes standard units (Btu). Note that the actual tables are numbered A.1.1 etc., for case A, B.1.1-etc., for case B.

Domestic supply

- Coal
  - (1) Total U.S.: Tables 1.1(S), 1.2(S), 8.1(P)
  - (2) By region: Tables 8.1(P)
- Petroleum
  - (1) Total U.S.: Tables 1.1(S), 1.2(S), 6.1(P)
  - (2) Crude oil: Tables 1.1(S), 1.2(S)
  - (3) Products: Table 6.1(P)
- Natural Gas
  - (1) Total U.S.: Tables 1.1(S), 1.2(S), 7.1(S)
  - (2) Offshore or onshore: Table 7.1(S)
  - (3) Category: Table 7.1(S)
- Electricity
  - (1) Total U.S.: Table 1.2(S), Table 5.3(P)
  - (2) Nuclear: Table 1.1(S), Table 1.2(S), Table 5.3(P)
  - (3) Hydroelectric/other: Table 1.1(S), Table 1.2(S), Table 5.3(P).

Imports (Exports)

- Coal: Tables 1.1(S), 1.2(S), 8.1(P)
- Total oil: Tables 1.2(S), 6.1(P)
- Crude oil: Tables 1.1(S), 6.1(P)
- Petroleum products: Tables 1.1(S), 6.1(P)
- Natural gas: Tables 1.1(S), 1.2(S), 7.1(S)
- Supplemental gas: Tables 1.1(S), 1.2(S), 7.1(S)
- Electricity: Table 1.1(S).

Consumption

- End-use sector: Tables 1.2(S), 1.3(S), 4.1(S), 4.2(S), 4.3(S), 4.4(S)
- Electric utilities Tables 1.1(S), 1.2(S), 1.3(S), 5.1(S)
- Coal: Tables 1.1(S), 1.2(S), 1.3(S), 5.1(S), 8.1(P)
- Petroleum: Tables 1.1(S), 1.2(S), 1.3(S), 5.1(S), 6.1(P)
- Natural gas: Tables 1.1(S), 1.2(S), 1.3(S), 5.1(S), 7.1(S)
- Electricity: Tables 1.3(S), 5.2(S)
- Refineries Table 1.2(S), 1.3(S).

Prices

- World oil price: Table 1.4(P)
- Sectoral: Table 1.4(S)
- Coal: Table 1.4(S)
- Oil: Table 1.4(S)
- Natural gas: Table 1.4(S), 6.1(S)
- Electricity: Table 1.4(S), 5.2(P), 5.5(P).

Electric Utilities

- Generation: Tables 1.2(S), 5.3(P)
- Fuel consumption: 1.1(S), 1.2(S), 1.3(S), 5.1(S)
- Electricity consumption: Tables 1.3(S), 5.2(P)
- Prices: Tables 1.4(S), 5.1(S), 5.2(P), 5.5(P)
- Capacity: Tables 5.3(P), 5.4(P).

Case A
Middle World Oil Price Forecast

The following is the established base case forecast. It employs the middle world oil price path assumptions and an additional assumption that there is no change in Federal regulations. The key Federal regulation that, given declining oil prices, appears to have a dominant effect on the supply mix in the energy balance is the Natural Gas Policy Act and the assumption that natural gas contracts negotiated under its environment will continue as negotiated. A detailed discussion is given in the Executive Summary.

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THE FOLLOWING SECTION OF TABLES ARE FOR THE:

CASE A:  MIDDLE WORLD OIL PRICE


THIS SECTION CONTAINS THE FOLLOWING TABLES:

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  COAL SUPPLY TABLE
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TABLE A.1.1. YEARLY SUPPLY AND DISPOSITION OF TOTAL ENERGY
CASE A: MIDDLE WORLD OIL PRICE
(QUADRILLION BTU PER YEAR)

	1975	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
SUPPLY												
PRODUCTION												
PETROLEUM..........	20.1	20.5	20.4	20.6	20.5	20.6	20.4	20.5	20.5	20.5	20.3	19.3
NATURAL GAS........	19.6	20.1	19.9	18.2	17.5	17.0	15.2	14.7	14.8	15.3	15.9	16.4
COAL...............	15.2	19.2	19.1	19.1	19.4	19.4	20.3	20.8	21.4	22.0	22.8	23.9
NUCLEAR............	1.9	2.7	2.9	3.0	3.2	3.7	4.1	4.7	5.3	5.8	6.1	6.3
HYDRO/GEO/OTHER....	3.2	3.0	2.9	3.3	3.2	3.1	3.1	3.1	3.2	3.2	3.2	3.2
SUBTOTAL..........	60.1	65.5	65.2	64.2	63.7	63.9	63.2	63.9	65.0	66.8	68.2	69.1
NET IMPORTS												
CRUDE OIL..........	8.7	10.6	8.8	6.8	7.5	10.4	13.0	12.7	12.0	11.4	11.0	11.9
OTHER PETROLEUM....	3.8	2.9	2.6	2.1	2.5	3.0	3.1	3.1	3.1	3.1	3.1	3.2
NG (CONTRACTED)(1).	0.9	1.0	.9	.9	1.1	1.2	1.2	1.2	1.2	1.2	1.2	1.2
OTHER GAS(2).......	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.2	0.0	0.0	0.0
COAL AND COKE......	-1.7	-2.4	-2.9	-2.8	-2.6	-2.7	-2.9	-3.0	-3.2	-3.4	-3.6	-3.8
ELECTRICITY........	0.1	.2	.2	.2	.2	0.3	0.3	0.3	0.3	0.3	0.4	0.4
SUBTOTAL..........	11.7	12.3	9.6	7.3	8.6	12.3	14.8	14.6	13.7	12.7	12.2	12.9
SPR ADDITIONS(3)....	0.0	-.1	-.7	-.4	-.4	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3
STOCK WITHDRAWALS...	-1.1	-1.8	0.0	-.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL SUPPLY.........	70.7	75.9	74.1	70.9	71.9	75.8	77.6	78.2	78.4	79.2	80.1	81.7
CONSUMPTION												
NON-ELEC UTILITY FUEL												
PETROLEUM..........	29.5	31.5	29.9	28.6	29.2	30.7	32.1	31.8	31.2	30.6	30.3	30.3
NATURAL GAS(4).....	16.7	16.6	16.1	15.0	14.9	14.5	13.7	13.5	13.5	13.7	13.9	14.1
COAL...............	4.0	3.4	3.4	3.0	2.9	3.2	3.3	3.3	3.4	3.5	3.7	3.8
SUBTOTAL..........	50.2	51.4	49.4	46.4	47.0	48.4	49.0	48.6	48.1	47.8	47.8	48.2
ELECTRIC UTILITY FUEL												
PETROLEUM..........	3.2	2.7	2.2	1.8	1.5	2.9	4.1	4.2	4.2	4.2	4.0	4.0
NATURAL GAS........	3.2	3.8	3.8	3.3	3.4	2.7	1.7	1.7	1.7	1.9	2.2	2.4
COAL...............	8.8	12.1	12.7	12.7	13.2	13.5	14.2	14.5	14.8	15.1	15.6	16.3
NUCLEAR............	1.9	2.7	2.9	3.0	3.2	3.7	4.1	4.7	5.3	5.8	6.1	6.3
HYDRO/GEO/OTHER(5).	3.4	3.2	3.1	3.5	3.4	3.4	3.5	3.5	3.5	3.5	3.5	3.6
SUBTOTAL..........	20.5	24.5	24.7	24.3	24.7	26.0	27.2	28.3	29.1	30.1	31.0	32.2
TOTAL CONSUMPTION....	70.7	75.9	74.1	70.7	71.7	74.4	76.3	76.9	77.2	78.0	78.9	80.4
ADJUSTMENTS												
REFINERY LOSSES(6).	0.0	0.0	0.0	0.0	-0.1	0.0	0.2	0.2	0.2	0.2	0.2	0.2
DISCREPANCY(7).....	0.0	0.0	0.0	0.2	0.3	1.4	1.1	1.1	1.0	1.0	1.0	1.1
TOTAL DISPOSITION....	70.7	75.9	74.1	70.9	71.9	75.8	77.6	78.2	78.4	79.2	80.1	81.7

NOTE: THE "ANNUAL ENERGY REVIEW" FOR 1982 WILL CONTAIN LATER REVISIONS TO HISTORICAL DATA FOR 1975, 1980 AND 1982.
NOTE: TOTALS MAY NOT EQUAL SUM OF COMPONENTS DUE TO INDEPENDENT ROUNDING. FOR TABLE FOOTNOTES AND SOURCES SEE PAGE 219.

TABLE A.1.2. SUPPLY/DEMAND BALANCE
CASE A: MIDDLE WORLD OIL PRICE
(QUADRILLION BTU PER YEAR)

	1975	1980	1985	1986	1987	1988	1989	1990
DOMESTIC SUPPLY								
COAL	15.2	19.2	20.3	20.8	21.4	22.0	22.8	23.9
NATURAL GAS	19.6	19.9	15.2	14.7	14.8	15.3	15.9	16.4
PETROLEUM	20.1	20.5	20.4	20.5	20.5	20.5	20.3	19.3
NUCLEAR	1.9	2.7	4.1	4.7	5.3	5.8	6.1	6.3
OTHER(1)	3.2	3.0	3.1	3.1	3.2	3.2	3.2	3.2
TOTAL DOMESTIC SUPPLY	60.0	65.3	63.2	63.9	65.0	66.8	68.2	69.1
NATURAL GAS IMPORTS	0.9	1.0	1.2	1.2	1.2	1.2	1.2	1.2
SUPPLEMENTAL GAS(2)	0.0	0.2	0.0	0.3	0.2	0.0	0.0	0.0
PETROLEUM IMPORTS	12.5	13.5	16.1	15.8	15.1	14.5	14.1	15.1
TOTAL SUPPLY(3)	73.4	80.0	80.4	81.2	81.6	82.5	83.6	85.4
DISPOSITION								
RESIDENTIAL	9.6	9.3	9.2	9.2	9.2	9.2	9.2	9.3
COMMERCIAL	5.5	5.9	6.6	6.7	6.8	6.8	6.8	6.9
INDUSTRIAL(4)	21.3	23.0	22.2	22.4	22.5	22.9	23.3	24.1
TRANSPORTATION	17.7	19.7	18.6	18.2	17.7	17.3	17.0	16.9
TOTAL END-USE CONSUMPTION	54.1	57.9	56.6	56.5	56.2	56.2	56.4	57.2
DISCREPANCY	0.2	-0.1	-0.2	-0.1	-0.2	-0.3	-0.4	-0.5
ADJUSTMENTS	19.1	22.2	24.0	24.8	25.6	26.6	27.6	28.7
UTILITY GENERATION	13.7	16.5	18.3	19.0	19.5	20.2	20.8	21.6
UTILITY TRANSMISSION	0.6	0.7	0.9	0.9	0.9	1.0	1.0	1.0
REFINERY(5)	0.0	0.0	0.2	0.2	0.2	0.2	0.2	0.2
GAS PIPELINE(6)	0.6	0.6	1.1	1.0	1.0	1.1	1.1	1.1
LEASE/PLANT FUEL(7)	1.4	1.0	1.1	1.[illegible]	1.1	1.1	1.2	1.2
COAL EXPORTS	1.7	2.4	2.9	[illegible].0	3.2	3.4	3.6	3.8
SPR ADDITIONS	0.0	0.1	0.3	0.3	0.3	0.3	0.3	0.3
STOCK WITHDRAWALS	1.1	1.8	0.0	0.0	0.0	0.0	0.0	0.0
RECLASSIFIED	0.0	-0.9	-0.7	-0.7	-0.7	-0.6	-0.6	-0.6
ADJUSTED CONSUMPTION	73.4	80.0	8[illegible].4	81.2	81.6	82.5	83.6	85.4
ELECTRIC UTILITY FUEL								
COAL	8.8	12.1	14.2	14.5	14.8	15.1	15.6	16.3
PETROLEUM	3.2	2.7	4.1	4.2	4.2	4.2	4.0	4.0
NATURAL GAS	3.2	3.8	1.7	1.7	1.7	1.9	2.2	2.4
TOTAL FOSSIL	15.2	18.6	20.0	20.4	20.7	21.2	21.7	22.6
NUCLEAR	1.9	2.7	4.1	4.7	5.3	5.8	6.1	6.3
OTHER	3.2	3.0	3.1	3.1	3.2	3.2	3.2	3.2
TOTAL	20.3	24.3	27.[illegible]	28.3	29.1	30.1	31.0	32.2
GENERATION	6.6	7.8	8.9	9.3	9.6	9.9	10.2	10.6

NOTE: TOTALS MAY NOT EQUAL SUM OF COMPONENTS DUE TO INDEPENDENT ROUNDING. FOR TABLE FOOTNOTES AND SOURCES SEE PAGE 219.

TABLE A.1.3. CONSUMPTION SUMMARY
CASE A: MIDDLE WORLD OIL PRICE
(QUADRILLION BTU PER YEAR)

	1975	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
RESIDENTIAL	9.571	9.335	9.104	9.236	9.143	9.174	9.207	9.230	9.236	9.238	9.250	9.269
STEAM COAL	0.091	0.065	0.080	0.082	0.071	0.078	0.076	0.074	0.073	0.071	0.069	0.068
NATURAL GAS	5.022	4.866	4.654	4.793	4.710	4.649	4.585	4.521	4.463	4.413	4.375	4.345
DISTILLATE(1)	1.923	1.417	1.375	1.303	1.230	1.308	1.328	1.336	1.331	1.318	1.302	1.286
LIQUID PETROLEUM GAS	0.528	0.539	0.536	0.570	0.590	0.565	0.576	0.582	0.582	0.578	0.574	0.570
ELECTRICITY	2.007	2.448	2.459	2.488	2.530	2.574	2.642	2.717	2.787	2.857	2.929	3.001
COMMERCIAL	5.513	5.892	5.818	5.866	6.182	6.438	6.601	6.708	6.759	6.776	6.816	6.865
STEAM COAL	0.135	0.095	0.107	0.122	0.086	0.097	0.095	0.092	0.090	0.087	0.085	0.082
NATURAL GAS	2.559	2.674	2.580	2.683	2.720	2.731	2.723	2.692	2.644	2.587	2.542	2.500
DISTILLATE(1)	0.622	0.556	0.540	0.511	0.670	0.738	0.775	0.801	0.815	0.820	0.824	0.827
LO-SULFUR RESIDUAL	0.506	0.566	0.470	0.376	0.490	0.542	0.569	0.588	0.598	0.602	0.605	0.608
LIQUID PETROLEUM GAS	0.093	0.095	0.095	0.101	0.090	0.080	0.078	0.076	0.074	0.072	0.070	0.068
ELECTRICITY	1.598	1.986	2.026	2.074	2.150	2.251	2.361	2.459	2.538	2.607	2.690	2.779
INDUSTRIAL(2)	18.503	20.185	19.513	16.876	17.365	18.908	19.614	19.848	20.023	20.513	20.950	21.707
STEAM COAL	1.619	1.388	1.570	1.626	1.501	1.771	1.800	1.853	1.933	2.038	2.148	2.257
METALLURGICAL COAL	2.178	1.793	1.647	1.057	1.132	1.262	1.302	1.325	1.337	1.353	1.359	1.375
NATURAL GAS	6.133	6.497	6.639	5.414	5.340	5.339	4.907	4.831	4.896	5.158	5.352	5.619
DISTILLATE	1.272	1.569	1.285	1.212	1.340	1.752	2.230	2.252	2.146	2.038	1.962	1.946
LO-SULFUR RESIDUAL	0.428	0.554	0.423	0.367	0.390	0.485	0.551	0.559	0.552	0.548	0.544	0.560
HI-SULFUR RESIDUAL	0.856	0.713	0.531	0.484	0.530	0.704	0.838	0.854	0.843	0.830	0.822	0.841
LIQUID PETROLEUM GAS	0.252	0.308	0.323	0.332	0.370	0.366	0.384	0.359	0.313	0.266	0.220	0.183
PET-CHEM FEEDSTOCK(3)	1.519	2.401	2.111	1.862	1.980	2.176	2.292	2.373	2.453	2.559	2.674	2.838
OTHER(4)	1.900	2.180	2.166	1.977	2.240	2.207	2.259	2.253	2.241	2.239	2.257	2.288
ELECTRICITY	2.346	2.781	2.817	2.545	2.620	2.846	3.051	3.189	3.310	3.484	3.611	3.801
TRANSPORTATION(5)	17.725	19.655	18.715	18.129	17.910	18.538	18.608	18.187	17.698	17.265	17.035	16.939
DISTILLATE	2.069	2.782	2.738	2.582	2.510	2.781	2.892	2.964	3.038	3.111	3.201	3.312
HI-SULFUR RESIDUAL	0.731	1.401	1.163	0.930	0.900	1.012	1.054	1.079	1.102	1.122	1.148	1.181
GASOLINE(6)	12.868	13.253	12.688	12.528	12.180	12.471	12.290	11.713	11.082	10.523	10.128	9.831
JET FUEL(7)	2.029	2.179	2.087	2.049	2.280	2.234	2.331	2.391	2.435	2.470	2.518	2.574
LIQUID PETROLEUM GAS	0.016	0.014	0.014	0.015	0.020	0.015	0.015	0.015	0.015	0.015	0.015	0.015
OTHER	0.000	0.014	0.014	0.014	0.010	0.014	0.014	0.014	0.014	0.014	0.014	0.014
ELECTRICITY	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.910	0.010	0.010	0.010
ELECTRIC UTILITY FUEL	20.360	24.243	24.462	24.203	24.480	25.951	27.238	28.260	29.106	30.135	31.044	32.190
STEAM COAL	8.790	12.122	12.707	12.697	13.190	13.542	14.153	14.489	14.757	15.135	15.610	16.290
NATURAL GAS	3.240	3.807	3.764	3.336	3.440	2.707	1.701	1.719	1.748	1.868	2.180	2.394
DISTILLATE(8)	0.350	0.121	0.077	0.048	0.090	0.182	0.347	0.376	0.328	0.348	0.379	0.465
LO-SULFUR RESIDUAL(9)	2.860	1.611	1.251	0.980	0.780	1.787	2.600	2.649	2.661	2.627	2.379	2.290
HI-SULFUR RESIDUAL	NA	0.922	0.898	0.789	0.600	0.947	1.185	1.199	1.206	1.207	1.196	1.209
HYDRO/GEO/OTHER(10)	3.220	2.988	2.864	3.340	3.190	3.115	3.133	3.149	3.153	3.168	3.186	3.212
NUCLEAR	1.900	2.672	2.901	3.013	3.190	3.671	4.118	4.678	5.253	5.782	6.114	6.331
REFINERY FUEL(11)	2.769	2.787	2.304	2.190	2.480	2.357	2.563	2.550	2.493	2.437	2.387	2.379
NATURAL GAS	0.975	0.846	0.668	0.574	0.720	0.437	0.298	0.280	0.289	0.325	0.350	0.380
DISTILLATE	0.035	0.018	0.011	0.011	0.010	0.012	0.013	0.013	0.012	0.012	0.012	0.012
LO-SULFUR RESIDUAL	NA	NA	NA	NA	0.090	0.118	0.151	0.151	0.143	0.131	0.123	0.119
HI-SULFUR RESIDUAL	0.269	0.213	0.167	0.137	0.200	0.295	0.476	0.489	0.468	0.424	0.389	0.360
LIQUID PETROLEUM GAS	0.050	0.043	0.024	0.030	0.030	0.026	0.028	0.028	0.027	0.026	0.026	0.026
OTHER(12)	0.390	0.436	0.359	0.348	0.360	0.366	0.398	0.396	0.387	0.378	0.370	0.369
STILL GAS	1.050	1.231	1.073	1.085	1.080	1.103	1.200	1.194	1.167	1.141	1.117	1.114

NOTE: TOTALS MAY NOT EQUAL SUM OF COMPONENTS DUE TO INDEPENDENT ROUNDING. FOR TABLE FOOTNOTES AND SOURCES SEE PAGE 219.

TABLE A.1.4. PRICE SUMMARY
CASE A: MIDDLE WORLD OIL PRICE
(1982 DOLLARS PER MILLION BTU)

	1975	1980	1985	1986	1987	1988	1989	1990
WORLD OIL PRICE.........	20.70	39.32	25.47	28.24	31.53	34.11	35.68	36.71
RESIDENTIAL	5.95	8.33	9.52	10.27	10.93	11.29	11.49	11.74
NATURAL GAS...........	2.75	4.16	6.65	7.43	8.01	8.28	8.35	8.53
DISTILLATE(1).........	4.75	8.59	6.27	6.93	7.72	8.35	8.75	9.02
LIQUID PETROLEUM GAS..	4.11	6.67	6.04	6.67	7.36	7.89	8.21	8.49
ELECTRICITY	15.61	16.78	17.11	17.61	18.00	18.21	18.26	18.36
COMMERCIAL	6.27	8.38	10.07	10.82	11.50	11.90	12.16	12.44
NATURAL GAS...........	2.17	3.84	6.42	7.24	7.85	8.14	8.27	8.48
DISTILLATE(1).........	4.30	8.06	5.94	6.56	7.31	7.91	8.29	8.54
LO-SULFUR RESIDUAL....	4.13	5.32	4.78	5.31	5.92	6.43	6.76	7.06
LIQUID PETROLEUM GAS..	NA	6.67	6.05	6.68	7.38	7.91	8.23	8.51
ELECTRICITY	15.55	17.21	17.35	17.88	18.40	18.50	18.64	18.74
INDUSTRIAL(2)	3.37	5.44	6.44	7.02	7.57	7.90	8.09	8.27
STEAM COAL............	1.81	1.55	2.10	2.13	2.16	2.20	2.25	2.33
METALLURGICAL COAL....	2.80	2.51	2.56	2.59	2.61	2.63	2.66	2.72
NATURAL GAS...........	1.49	2.90	5.62	6.45	7.00	7.13	7.17	7.23
DISTILLATE............	4.24	7.99	5.84	6.47	7.21	7.81	8.18	8.43
LO-SULFUR RESIDUAL....	4.11	5.14	4.70	5.22	5.82	6.32	6.64	6.95
HI-SULFUR RESIDUAL....	2.93	NA	4.19	4.72	5.34	5.86	6.19	6.49
LIQUID PETROLEUM GAS..	3.83	6.34	5.83	6.44	7.11	7.62	7.91	8.18
PET-CHEM FEEDSTOCK(3).	NA	7.89	6.72	7.41	8.25	8.92	9.34	9.63
OTHER(4)..............	NA	NA	5.18	5.71	6.35	6.88	7.21	7.45
ELECTRICITY	9.42	11.67	14.15	14.59	15.03	15.16	15.23	15.35
TRANSPORTATION(5)	6.72	9.91	7.75	8.43	9.21	9.78	10.07	10.21
DISTILLATE............	5.85	8.39	6.21	6.87	7.66	8.29	8.69	8.95
HI-SULFUR RESIDUAL....	2.93	3.97	3.65	4.13	4.68	5.16	5.45	5.76
GASOLINE(6)...........	7.57	11.32	8.69	9.47	10.35	10.97	11.29	11.41
JET FUEL(7)...........	3.69	7.51	6.55	7.23	8.04	8.68	9.08	9.36
LIQUID PETROLEUM GAS..	NA	NA	5.78	6.39	7.07	7.58	7.88	8.16
ELECTRICITY	NA	NA	16.71	17.26	17.79	17.99	18.08	18.16
ELECTRIC UTILITY FUEL	2.04	1.84	2.07	2.19	2.29	2.36	2.40	2.47
STEAM COAL............	1.58	1.71	1.74	1.76	1.77	1.79	1.81	1.86
NATURAL GAS...........	1.14	2.80	5.54	6.43	7.00	7.02	7.13	7.19
DISTILLATE(8).........	3.28	7.22	5.87	6.50	7.24	7.84	8.21	8.47
LO-SULFUR RESIDUAL(9).	3.27	5.90	4.78	5.31	5.92	6.44	6.68	6.94
HI-SULFUR RESIDUAL....	NA	4.55	3.67	4.14	4.78	5.16	5.46	5.74
NUCLEAR...............	NA	.85	0.85	0.85	0.85	0.85	0.85	0.85
REFINERY FUEL	NA	NA	2.31	2.59	2.98	3.14	3.20	3.39
NATURAL GAS...........	NA	3.08	4.75	5.50	6.06	6.21	6.24	6.25
DISTILLATE............	NA	6.09	5.14	5.70	6.36	6.90	7.23	7.46
LO-SULFUR RESIDUAL....	NA	NA	4.12	4.59	5.13	5.59	5.88	6.17
HI-SULFUR RESIDUAL....	NA	4.89	3.47	3.93	4.47	4.94	5.23	5.51
LIQUID PETROLEUM GAS..	NA	NA	5.13	5.69	6.30	6.76	7.03	7.20
OTHER(10).............	NA	NA	5.07	5.60	6.24	6.77	7.10	7.34

NOTE: TOTALS MAY NOT EQUAL SUM OF COMPONENTS DUE TO INDEPENDENT ROUNDING. FOR TABLE FOOTNOTES AND SOURCES SEE PAGE 219.

Appendix Table 2.1: Real Gross Domestic Product Annual Average Compound Growth Rates[a] (Percent)

	1960-1973	1973-1980	1980-1990
United States	4.1	2.2	2.5
Canada	5.5	2.9	2.2
Japan	9.9	3.7	3.1
Western Europe	4.8	2.3	2.2
Finland/Norway/Sweden	4.3	2.7	2.4
United Kingdom/Ireland	3.2	1.0	0.9
Benelux/Denmark	4.8	2.2	1.9
West Germany	4.5	2.3	1.7
France	5.5	2.9	2.5
Austria/Switzerland	3.8	1.4	1.8
Spain/Portugal	7.2	2.5	3.2
Italy	5.3	2.8	3.0
Greece/Turkey	6.6	4.0	4.4
Australia/New Zealand	5.1	2.3	2.7
Total OECD	5.0	2.5	2.4
Total Non-OECD	6.3	4.5	3.3
Total Free World	5.2	2.9	2.6

[a] Aggregates at 1975 United States dollars and 1975 exchange rates.

Source: Calculated using data from: Wharton Econometric Forecasting Associates, World Historical Data (Philadelphia, Pennsylvania, 1982); and International Bank of Reconstruction and Development, World Tables, Second Edition (Baltimore, Maryland, 1980).

Appendix Table 2.2 Alternate OPEC Oil Production Capacities, 1981 to 1990
(Million Barrels per Day)

Country		Projections			
	1981	1985		1990	
		Low	High	Low	High
Crude Oil and Natural Gas Liquids					
Algeria	1.4	1.0	1.1	0.7	1.0
Ecuador	0.2	0.1	0.2	0.2	0.2
Gabon	0.2	0.1	0.2	0.1	0.2
Indonesia	3.0	2.5	3.5	2.5	3.5
Iran	3.5	0.8	4.0	4.0	5.0
Iraq	3.5	0.8	4.0	4.0	5.0
Kuwait	2.1	1.6	1.6	1.5	1.5
Libya	2.1	1.8	2.2	1.8	2.2
Neutral Zone	0.6	0.5	0.6	0.4	0.5
Nigeria	2.2	1.9	2.2	1.7	1.9
Qatar	0.6	0.6	0.7	0.5	0.7
Saudi Arabia	10.4	10.0	10.7	10.0	11.0
United Arab Emirates	2.4	2.2	2.4	2.0	2.2
Venezuela	2.4	2.4	2.4	2.0	2.2
Total	32.8	27.1	33.5	28.6	33.6

Source: U.S. Department of Energy, Office of International Affairs.

Appendix Table 2.3 Free World Oil Consumption and Production;[a] History and High, Middle, and Low Price Case Projections[b]
(Million Barrels per day)

Country or Region	1960	1973	1981	1985 High Prices	1985 Mid Prices	1985 Low Prices	1990 High Prices	1990 Mid Prices	1990 Low Prices
World Oil Price (1982 dollars per barrel)	8.69	8.00	39.27	34.00	25.00	21.00	48.00	37.00	28.00
Consumption									
United States[c]	9.8	17.6	16.5	17.0	18.6	19.6	15.7	17.4	19.3
Canada	0.8	1.7	1.8	1.8	1.9	1.9	1.7	2.0	2.3
Japan	0.7	5.1	4.8	4.6	4.9	5.0	4.7	5.3	6.1
OECD Europe	4.5	15.2	12.6	12.0	12.8	13.4	11.6	13.5	16.0
OPEC	0.7	1.9	2.8	3.2	3.2	3.2	3.9	3.9	3.9
Other Countries[d]	2.4	7.0	8.9	9.1	9.7	10.1	10.2	10.7	11.3
Total Consumption[e]	19.2	49.2	47.4	47.6	50.8	53.1	47.9	52.8	58.9
Production									
United States	8.1	11.4	10.7	10.8	10.6	10.4	10.6	10.0	9.5
Canada	0.5	2.1	1.6	1.5	1.5	1.5	1.7	1.7	1.6
OECD Europe	0.3	0.5	2.8	3.4	3.4	3.4	3.1	3.0	2.8
OPEC	8.7	31.3	23.7	23.2	25.8	27.6	22.5	27.7	33.7
Other Countries[d]	1.1	2.6	6.7	8.8	8.0	8.8	10.5	10.2	9.9
Total Production[e]	19.0	48.9	45.5	47.7	50.1	51.7	48.5	52.6	57.5
Net Exports from Centrally Planned Economies (Imports)	0.5	0.8	1.2	0.5	1.0	1.5	0.0	0.5	1.5
Stock Change	-0.3	-0.5	-0.7	0.6	0.3	0.1	0.6	0.3	0.1

[a] Includes crude oil and natrual gas liquids. United States includes other hydrocarbons, hydrogen, and refinery gains.

[b] Projections derived using assumptions under the midprice case, except for world oil prices.

[c] Includes Puerto Rico, Virgin Islands, and purchases for the Strategic Petroleum Reserve.

[d] Excludes Centrally Planned Economies (CPE).

[e] Numbers may not add to totals because of rounding.

Source: Historical Data: U.S. Department of Energy, Energy Information Administration, 1981 Annual Report to Congress, DOE/EIA-173(81)/3 (Washington, D.C., 1982); Monthly Energy Review DOE/EIA-0035 (82/11), and 1981 International Energy Annual DOE/EIA-01219(81); Organisation for Economic Cooperation and Development/International Energy Agency, Quarterly Oil Statistics, Second Quarter 1982 (Paris, France, 1982); and Petroleum Economics Limited Quarterly Supply/Demand Outlook, (London, England, 1982).

Appendix Table 2.4 World Oil Prices Sensitivity Anaysis
(1982 Dollars per Barrel)

Scenario	1985	1990	2000
	World Oil Prices		
Midprice Case	25.00	37.00	59.00
	Differences from Midprice Case Prices		
Sensitivity Scenario[a]			
High Economic Growth	0.46	1.80	9.00
Low Economic Growth	-0.42	-0.93	-6.83
Low Price Elasticity	-0.30	1.91	14.19
High Price Elasticity	0.33	-1.80	-7.16
Low Income Feedback Elasticity	-0.06	0.33	0.60
High Income Feedback Elasticity	-0.06	-0.32	-0.58
Low OPEC Oil Production Capacity	7.99	2.11	3.12
High OPEC Oil Production Capacity	-3.79	-2.54	-5.72
Low Non-OPEC Oil Supply	4.19	10.43	20.57
High Non-OPEC Oil Supply	-2.29	-7.90	-11.55
	World Oil Price Range		
Combined Uncertainty[b]			
Low Price Scenario	21.00	28.00	42.00
High Price Scenario	34.00	48.00	85.00

[a] Scenario prices are derived by varying each sensitivity factor separately while holding all other factors at midprice case level. High and low ranges for the sensitivity factors are -0.4 and +0.4 percent per year for economic growth rates; -25 and +25 percent of estimated price and income-feedback elasticities; -9 to +14 percent of midprice case OPEC production capacity values by 2000; and -26 to +26 percent of midprice case non-OPEC oil supply values by 2000.

[b] The square root of the sum of the squares of the individual high, or low, differentials added to, or subtracted from, the midprice.

TABLE A.3.1. NATIONAL MACROECONOMIC INDICATORS
CASE A: MIDDLE WORLD OIL PRICE

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
REAL GROSS NATIONAL PRODUCT(1).....	2408.8	2455.6	2411.2	2444.0	2556.2	2667.1	2754.1	2840.2	2912.5	2990.0	3082.0
GROSS NATIONAL PRODUCT DEFLATOR(2).	1.0931	1.1944	1.2681	1.3314	1.3997	1.4767	1.5635	1.6664	1.7859	1.9105	2.0402
REAL GROWTH(3)....................	-0.41	1.98	-1.81	1.16	4.59	4.34	3.26	3.13	2.54	2.66	3.08
INFLATION(3)......................	9.31	9.45	5.99	7.17	5.13	5.50	5.88	6.58	7.18	6.97	6.79
REAL PERSONAL DISPOSABLE INCOME(1).	1663.6	1704.6	1723.3	1745.1	1827.2	1895.8	1954.5	1998.5	2030.8	2078.2	2129.7
UNEMPLOYMENT RATE(3)..............	7.1	7.6	9.7	10.65	9.57	8.42	7.97	7.71	7.64	7.66	7.49
POPULATION(5).....................	222.138	224.175	226.219	228.160	230.305	232.344	234.480	236.597	238.760	240.846	242.977
REAL PERS DISP INCOME PER CAPITA(6)	7487.0	7603.9	7617.8	7648.5	7933.8	8159.6	8335.6	8446.7	8505.5	8628.9	8765.2
RESIDENTIAL HOUSING STARTS(5)......	1.292	1.084	1.060	1.456	1.666	1.866	1.872	1.885	1.864	1.806	1.754
AAA BOND RATE(3)..................	11.94	14.17	13.79	11.13	10.36	10.28	10.38	10.41	10.36	10.13	9.84
MORTGAGE RATE(3)..................	12.66	14.70	15.14	8.35	8.86	9.26	9.68	9.87	9.84	9.18	8.92
FEDERAL RESERVE PRODUCTION INDEX(4)	147.0	151.0	138.6	139.95	152.80	163.22	169.38	175.37	180.84	187.53	196.07

(1) BILLIONS OF 1979 DOLLARS.
(2) INDEX EQUAL TO 1.0 IN 1979.
(3) PERCENTAGE.
(4) INDEX EQUAL TO 100 IN 1967.
(5) MILLIONS OF UNITS.
(6) 1979 DOLLARS.
NOTE: ENTRIES FOR 1980, 1981 AND 1982 ARE HISTORICAL DATA.
SOURCES: ON PAGE 222, SEE 9, PAGE 164, TABLE B-2; 9, PAGE 166, TABLE B-3; 9, PAGE 191, TABLE B-24; 9, PAGE 201, TABLF B-33; 9, PAGE 216, TABLE B-47; 9, PAGE 240, TABLE B-67; AND 9, PAGE 210, TABLE B-42.

TABLE A.4.1. RESIDENTIAL SECTOR FUEL CONSUMPTION BY END-USE SERVICE
CASE A: MIDDLE WORLD OIL PRICE
(TRILLIONS OF BTU PER YEAR)

	1980	1985	1986	1987	1988	1989	1990
SPACE HEATING							
ELECTRICITY(1).....	201.	244.	260.	274.	288.	302.	316.
NATURAL GAS........	3225.	2995.	2930.	2868.	2813.	2769.	2731.
FUEL OIL...........	1172.	1091.	1099.	1095.	1083.	1068.	1052.
LIQUID GAS.........	390.	414.	418.	418.	416.	413.	410.
COAL...............	65.	76.	74.	73.	71.	69.	68.
MARKET TOTAL.......	5054.	4820.	4781.	4729.	4671.	4621.	4577.
WOOD...............	818.	1127.	1151.	1172.	1187.	1197.	1203.
WATER HEATING							
ELECTRICITY........	286.	317.	328.	338.	348.	358.	368.
NATURAL GAS........	1055.	1030.	1032.	1035.	1040.	1046.	1052.
FUEL OIL...........	244.	237.	237.	236.	235.	234.	234.
LIQUID GAS.........	149.	162.	164.	163.	162.	161.	160.
MARKET TOTAL.......	1734.	1746.	1760.	1773.	1785.	1799.	1814.
AIR CONDITIONING							
ELECTRICITY........	351.	380.	389.	398.	407.	416.	426.
NATURAL GAS........	12.	13.	13.	13.	13.	13.	13.
MARKET TOTAL.......	363.	393.	402.	410.	420.	429.	439.
OTHER END-USES(2)							
ELECTRICITY........	1610.	1700.	1740.	1777.	1814.	1853.	1891.
NATURAL GAS........	574.	548.	547.	547.	547.	547.	548.
MARKET TOTAL.......	2185.	2248.	2287.	2324.	2361.	2400.	2439.
FOR ALL END USES							
ELECTRICITY........	2448.	2642.	2717.	2787.	2857.	2929.	3001.
NATURAL GAS........	4866.	4585.	4521.	4463.	4413.	4375.	4345.
FUEL OIL...........	1417.	1328.	1336.	1331.	1318.	1302.	1286.
LIQUID GAS.........	539.	576.	582.	582.	578.	574.	570.
COAL...............	65.	76.	74.	73.	71.	69.	68.
MARKET TOTAL.......	9335.	9207.	9230.	9236.	9238.	9250.	9269.
WOOD...............	818.	1127.	1151.	1172.	1187.	1197.	1203.

(1) ELECTRIC SPACE HEATING INCLUDES BOTH ELECTRIC RESISTANCE AND HEAT PUMPS.
(2) SOME OF THE MAJOR USES ARE LIGHTING, COOKING, REFRIGERATION, WASHING, AND DRYING.
NOTE: ENTRIES FOR 1980 ARE A COMBINATION OF HISTORICAL AND ESTIMATED VALUES.
SOURCES: ON PAGE 222, SEE 1, PAGE 15; AND 19, PAGE 101, TABLE A4.

TABLE A.4.2. COMMERCIAL SECTOR ENERGY CONSUMPTION AND FLOORSPACE BY BUILDING CATEGORY
CASE A: MIDDLE WORLD OIL PRICE
(CONSUMPTION IN QUADRILLION BTU PER YEAR, FLOORSPACE IN BILLIONS OF SQUARE FEET)

		1980	1985	1986	1987	1988	1989	1990
ALL CATEGORIES...	ALL FUELS.......	5.892	6.601	6.708	6.755	6.776	6.816	6.865
	NATURAL GAS.....	2.674	2.723	2.692	2.644	2.587	2.542	2.500
	ELECTRICITY.....	1.907	2.362	2.459	2.538	2.607	2.690	2.779
	FUEL OIL(1).....	1.122	1.344	1.389	1.413	1.422	1.430	1.435
	OTHER FUELS(2)..	0.190	0.173	0.169	0.164	0.159	0.155	0.151
	FLOORSPACE......	44.75	51.29	52.78	54.04	55.15	56.48	57.93
WAREHOUSE........	ALL FUELS.......	0.826	0.936	0.956	0.968	0.976	0.988	1.000
	NATURAL GAS.....	0.376	0.377	0.372	0.365	0.357	0.349	0.343
	ELECTRICITY.....	0.254	0.322	0.334	0.345	0.356	0.368	0.380
	FUEL OIL(1).....	0.167	0.211	0.224	0.233	0.239	0.247	0.254
	OTHER FUELS(2)..	0.028	0.026	0.026	0.025	0.024	0.024	0.023
	FLOORSPACE......	6.29	7.29	7.50	7.70	7.89	8.10	8.31
INSTITUTION(3)...	ALL FUELS.......	0.675	0.717	0.723	0.720	0.710	0.704	0.699
	NATURAL GAS.....	0.392	0.366	0.351	0.338	0.324	0.313	0.302
	ELECTRICITY.....	0.108	0.135	0.140	0.144	0.148	0.154	0.159
	FUEL OIL(1).....	0.155	0.205	0.216	0.221	0.223	0.224	0.224
	OTHER FUELS(2)..	0.019	0.017	0.016	0.016	0.015	0.014	0.014
	FLOORSPACE......	1.65	1.89	1.95	1.99	2.03	2.08	2.13
OFFICE...........	ALL FUELS.......	1.935	2.189	2.232	2.257	2.269	2.290	2.315
	NATURAL GAS.....	0.755	0.767	0.758	0.744	0.729	0.716	0.703
	ELECTRICITY.....	0.726	0.899	0.939	0.970	0.996	1.028	1.063
	FUEL OIL(1).....	0.393	0.466	0.481	0.489	0.493	0.496	0.499
	OTHER FUELS(2)..	0.062	0.056	0.055	0.054	0.052	0.051	0.050
	FLOORSPACE......	15.74	18.11	18.67	19.12	19.50	19.98	20.51
HOTEL AND MOTEL..	ALL FUELS.......	0.299	0.342	0.346	0.348	0.347	0.348	0.350
	NATURAL GAS.....	0.142	0.149	0.147	0.144	0.141	0.138	0.135
	ELECTRICITY.....	0.114	0.146	0.152	0.157	0.160	0.165	0.171
	FUEL OIL(1).....	0.033	0.037	0.038	0.038	0.038	0.037	0.036
	OTHER FUELS(2)..	0.010	0.009	0.009	0.009	0.008	0.008	0.008
	FLOORSPACE......	2.12	2.42	2.50	2.56	2.60	2.67	2.74
RETAIL/WHOLESALE.	ALL FUELS.......	1.552	1.806	1.841	1.861	1.872	1.888	1.906
	NATURAL GAS.....	0.733	0.793	0.792	0.786	0.777	0.771	0.766
	ELECTRICITY.....	0.545	0.682	0.713	0.738	0.761	0.788	0.816
	FUEL OIL(1).....	0.223	0.283	0.289	0.290	0.289	0.285	0.281
	OTHER FUELS(2)..	0.051	0.048	0.047	0.046	0.045	0.044	0.043
	FLOORSPACE......	13.18	15.37	15.87	16.30	16.68	17.13	17.63
MISCELLANEOUS(4).	ALL FUELS.......	0.606	0.612	0.610	0.606	0.602	0.598	0.595
	NATURAL GAS.....	0.276	0.276	0.272	0.267	0.261	0.256	0.251
	ELECTRICITY.....	0.160	0.178	0.181	0.183	0.186	0.188	0.190
	FUEL OIL(1).....	0.151	0.142	0.142	0.142	0.141	0.141	0.141
	OTHER FUELS(2)..	0.019	0.016	0.016	0.015	0.014	0.014	0.013
	FLOORSPACE......	5.76	6.20	6.29	6.37	6.44	6.52	6.60

(1) FUEL OIL CONSISTS OF LOW SULFUR RESIDUAL OIL AND DISTILLATE OIL.
(2) OTHER FUELS CONSIST OF LIQUID PETROLEUM GASES AND COAL.
(3) INCLUDES MAINLY HEALTH FACILITIES AND PENAL INSTITUTIONS.
(4) INCLUDES MAINLY RELIGIOUS FACILITIES, ASSEMBLEY HALLS, PARKING GARAGES, AND RECREATIONAL FACILITIES.

NOTE: ENTRIES FOR 1980 ARE A COMBINATION OF HISTORICAL AND ESTIMATED VALUES.
SOURCES: ON PAGE 222, SEE 1, PAGE I6.

TABLE A.4.3. INDUSTRIAL SECTOR ENERGY CONSUMPTION
CASE A: MIDDLE WORLD OIL PRICE
(TRILLIONS OF BTU PER YEAR)

	1980	1985	1986	1987	1988	1989	1990
COAL.....................	1387.88	1800.39	1852.90	1932.94	2038.12	2148.25	2256.76
NATURAL GAS..............	6497.36	4906.59	4830.55	4895.95	5157.55	5352.27	5614.24
(RAW MATERIALS(1).....	650.77	489.58	476.12	471.78	478.23	488.28	494.85)
DISTILLATE...............	1568.69	2230.28	2252.37	2145.84	2038.19	1961.65	1945.71
HI-SULFUR RESIDUAL......	713.20	837.91	854.27	843.16	830.30	822.17	840.63
LO-SULFUR RESIDUAL......	553.58	551.23	558.83	551.52	547.54	543.68	559.93
ELECTRICITY..............	2780.85	3051.37	3188.60	3309.77	3484.43	3611.45	3801.18
LIQUID PETROLEUM GAS....	307.88	383.78	358.73	313.10	266.06	219.94	182.99
PET-CHEM FEEDSTOCKS(2)..	2401.48	2291.92	2373.35	2452.92	2559.23	2674.48	2836.00
METALLURGICAL COAL......	1793.34	1302.24	1324.68	1336.65	1352.73	1358.75	1374.51
OTHER(3).................	2180.32	2258.64	2253.37	2240.71	2239.25	2257.45	2288.56
TOTAL ENERGY............	20184.58	19614.33	19847.61	20022.55	20513.38	20950.08	21700.50

(1) NATURAL GAS CONSUMED AS A FEEDSTOCK BY THE CHEMICAL INDUSTRY (ALREADY INCLUDED IN THE NATURAL GAS TOTAL).

(2) CONSISTS OF STILL GAS USED FOR FEEDSTOCK PUROPSES, KAPTHAS LESS THAN 400 DEGREES, OTHER FUELS GREATER THAN 400 DEGREES, AND LIQUID PETROLEUM GASES USED FOR GAS UTILITY FUEL AND FOR CHEMICAL FEEDSTOCKS.

(3) ASPHALT, PETROLEUM COKE, LUBRICANTS, INDUSTRIAL KEROSENE, WAXES AND MISCELLANEOUS PETROLEUM PRODUCTS.

NOTE: INDUSTRIAL SECTOR TOTAL DIFFER FROM THOSE SHOWN IN THE "MONTHLY ENERGY REVIEW" BY EXCLUDING ELECTRICITY LOSSES, GASOLINE, NATURAL GAS USED AS A LEASE AND PLANT FUEL, AND ALL REFINERY FUELS EXCEPT COAL AND ELECTRICITY, AND BY INCLUDING LUBRICANTS CONSUMED BY THE TRANSPORTATION SECTOR. IN 1980 ONLY, THE RESIDUAL AND DISTILLATE DETAIL HAS BEEN CONVERTED TO THE NEW BASIS FOR CONSISTENCY WITH THE PETROLEUM BALANCE TABLE AND WITH 1980 FUEL DETAIL USED IN THE "SHORT-TERM ENERGY OUTLOOK."

NOTE: ENTRIES FOR 1980 ARE HISTORICAL DATA.

SOURCES: ON PAGE 222. SEE 1, PAGE 17; 15, PAGE 11, TABLE 5; AND 15, PAGE 127, TABLE 55.

TABLE A.4.4. TRANSPORTATION SECTOR ENERGY CONSUMPTION BY MODE
CASE A: MIDDLE WORLD OIL PRICE

	1980	1985	1986	1987	1988	1989	1990
FUEL CONSUMPTION, ALL MODES							
GASOLINE(1)	13.253	12.290	11.713	11.082	10.523	10.128	9.631
DISTILLATE(1)	2.782	2.892	2.964	3.038	3.111	3.201	3.312
JET FUEL(1)	2.179	2.331	2.391	2.435	2.470	2.518	2.574
RESIDUAL(1)	1.401	1.054	1.079	1.102	1.122	1.148	1.171
LIQUID GAS(1)	0.014	0.015	0.015	0.015	0.015	0.015	0.015
FUEL USE IN LIGHT DUTY VEHICLES							
SALES:LIGHT DUTY VEHICLES(3)	10.750	13.254	13.644	14.123	14.702	15.081	15.004
VEHICLE-MILES:TOTAL(2)	1383.	1607.	1634.	1651.	1668.	1697.	1731.
FLEET-MILES PER GALLON:TOTAL	14.17	16.68	17.74	18.89	20.01	21.04	21.98
PERCENT FLEET VMT DIESEL	0.010	0.021	0.025	0.032	0.039	0.046	0.055
VEHICLE-MILES:GAS(2)	1368.	1574.	1592.	1599.	1603.	1618.	1636.
FLEET-MILES PER GALLON:GAS	13.95	16.46	17.47	18.55	19.58	20.51	21.36
FUEL USE:GAS(4)	98.080	95.610	91.133	86.225	81.909	78.902	76.606
VEHICLE-MILES:DIESEL(2)	14.	33.	42.	52.	64.	79.	95.
FLEET-MILES PER GALLON:DIESEL	25.34	27.30	28.43	29.63	30.73	31.69	32.54
FUEL USE:DIESEL(4)	0.564	1.214	1.465	1.761	2.097	2.481	2.907
FUEL USE IN HEAVY TRUCKS							
SALES:HEAVY TRUCKS(3)	0.487	0.644	0.675	0.706	0.736	0.756	0.734
VEHICLE-MILES:TOTAL(2)	105.	125.	128.	131.	134.	137.	142.
FLEET-MILES PER GALLON:TOTAL	5.82	6.85	7.07	7.29	7.52	7.75	7.94
PERCENT FLEET VMT DIESEL	0.591	0.656	0.669	0.683	0.697	0.710	0.722
VEHICLE-MILES:GAS(2)	43.	43.	42.	42.	41.	40.	39.
FLEET-MILES PER GALLON:GAS	6.84	8.29	8.60	8.92	9.25	9.56	9.78
FUEL USE:GAS(4)	6.266	5.173	4.918	4.656	4.386	4.156	4.018
VEHICLE-MILES:DIESEL(2)	62.	82.	86.	89.	93.	97.	102.
FLEET-MILES PER GALLON:DIESEL	5.09	6.09	6.31	6.54	6.77	7.01	7.23
FUEL USE:DIESEL(4)	12.168	13.405	13.554	13.674	13.756	13.903	14.138
FUEL USE IN AIR							
REVENUE PASSENGER-MILES(3)	265.	344.	361.	374.	385.	398.	414.
AVERAGE FLIGHT SIZE	158.	167.	170.	172.	174.	176.	178.
LOAD FACTOR	0.62	0.64	0.64	0.65	0.65	0.66	0.66
FUEL BURNED PER SEAT-MILE(5)	0.023	0.022	0.021	0.021	0.021	0.020	0.020
TOTAL JET FUEL(4)	16.543	19.029	19.518	19.874	20.156	20.549	21.009
FUEL USE IN OTHER							
NON-HWY DSL(1)	4.438	4.697	4.779	4.859	4.925	4.995	5.077
RESIDUAL(1)	1.550	1.795	1.837	1.876	1.910	1.955	2.011

(1) QUADRILLION BTU PER YEAR.
(2) BILLIONS PER YEAR.
(3) MILLIONS PER YEAR.
(4) BILLIONS OF GALLONS PER YEAR.
(5) GALLONS PER YEAR.
NOTE: ENTRIES FOR 1980 ARE A COMBINATION OF HISTORICAL AND ESTIMATED VALUES.

TABLE A.5.1. ELECTRIC UTILITY FUEL PRICES AND CONSUMPTION
CASE A: MIDDLE WORLD OIL PRICE
(1982 DOLLARS PER MILLION BTU; TRILLIONS OF BTU PER YEAR)

YEARS	COAL	NATURAL GAS	DISTILLATE	LO-S RESID	HI-S RESID	FOSSIL FUEL	NUCLEAR	HYDRO	ALL FUELS
FUEL PRICES									
1980	1.71	2.80	7.22	5.90	4.55	NA	NA	--	NA
1985	1.74	5.54	5.84	4.78	3.67	2.64	0.85	--	2.07
1986	1.76	6.43	6.50	5.31	4.14	2.83	0.85	--	2.19
1987	1.77	7.00	7.23	5.92	4.69	3.00	0.85	--	2.29
1988	1.79	7.02	7.81	6.44	5.16	3.12	0.85	--	2.36
1989	1.81	7.13	8.18	6.68	5.46	3.19	0.85	--	2.40
1990	1.86	7.19	8.43	6.94	5.74	3.28	0.85	--	2.47
FUEL CONSUMPTION									
1980	12122.	3807.	121.	1611.	922.	18583.	2672.	2988.	24243.
1985	14153.	1701.	347.	2600.	1185.	19987.	4118.	3133.	27238.
1986	14489.	1693.	376.	2649.	1199.	20407.	4678.	3149.	28234.
1987	14757.	1748.	328.	2661.	1206.	20700.	5253.	3153.	29106.
1988	15135.	1868.	348.	2627.	1207.	21185.	5782.	3168.	30136.
1989	15610.	2180.	379.	2379.	1196.	21744.	6114.	3186.	31044.
1990	16290.	2394.	465.	2290.	1209.	22647.	6331.	3212.	32190.

NA=NOT AVAILABLE.
--=NOT APPLICABLE.
NOTE: ENTRIES FOR 1980 ARE HISTORICAL DATA.
SOURCES: ON PAGE 222. SEE 1; 2, PP 160-170, TABLES B1, B2, B3, AND B4; 2, PP 253-255, TABLE C9; 2, PP 262-263, TABLE C13; 2, PP 270-271, TABLE C17; AND 2, PP 290-291, TABLE C27.

TABLE A.5.2. END-USE ELECTRICITY PRICES AND CONSUMPTION
CASE A: MIDDLE WORLD OIL PRICE
(1982 MILLS PER KWH; BILLION KWH PER YEAR)

YEARS	RESIDENTIAL	COMMERCIAL	TRANSPORTATION	INDUSTRIAL	AVG./TOTAL
END-USE PRICES					
1980	57.25	58.72	NA	39.82	50.82
1985	58.37	59.19	57.03	48.28	54.79
1986	60.07	61.02	58.90	49.77	56.43
1987	61.70	62.79	60.72	51.27	58.03
1988	62.15	63.38	61.40	51.72	58.45
1989	62.32	63.61	61.68	51.96	58.64
1990	62.65	63.95	61.95	52.39	58.96
END-USE CONSUMPTION					
1980	717.50	558.91	0.00	815.06	2091.47
1985	774.37	692.15	3.05	894.36	2363.92
1986	796.22	720.59	3.05	934.58	2454.43
1987	816.88	743.97	3.05	970.09	2533.98
1988	837.41	764.10	3.05	1021.29	2625.84
1989	858.41	788.41	3.05	1058.52	2708.38
1990	879.48	814.63	3.05	1114.11	2811.27

NA=NOT AVAILABLE.
NOTE: ENTRIES FOR 1980 ARE HISTORICAL DATA.
SOURCES: ON PAGE 222, SEE 1, PP 15-18; AND 2, PP 229-40, TABLES C1, C2, C3, AND C4.

TABLE A.5.3. ELECTRIC UTILITY CAPACITY AND GENERATION
CASE A: MIDDLE WORLD OIL PRICE
(CAPACITY IN GIGAWATTS; GENERATION IN BILLION KWH)

CAPACITY TYPE		1980	1985	1986	1987	1988	1989	1990
COAL STEAM	CAPACITY...	176.58	224.96	233.92	238.89	246.92	255.00	265.72
	GENERATION.	943.6	1148.1	1185.7	1213.7	1249.7	1291.9	1350.5
NATURAL GAS STEAM	CAPACITY...	40.99	40.99	40.99	40.99	40.99	40.99	40.99
	GENERATION.	158.2	71.3	70.1	70.7	71.1	67.3	66.6
OIL STEAM	CAPACITY...	32.27	35.07	35.07	35.07	35.12	35.12	35.12
	GENERATION.	115.0	126.2	127.1	126.5	126.1	121.8	123.9
NG/COAL STEAM	CAPACITY...	32.31	32.46	32.46	32.46	32.46	32.46	32.46
	GENERATION.	123.5	104.3	101.9	100.9	102.5	104.5	108.8
OIL/COAL STEAM	CAPACITY...	40.18	40.18	40.18	40.18	40.18	40.18	40.18
	GENERATION.	149.5	151.4	151.2	151.5	152.3	155.6	160.5
NG/OIL STEAM	CAPACITY...	69.81	69.81	69.81	69.81	69.81	69.81	69.81
	GENERATION.	233.0	240.8	243.6	246.1	247.9	251.3	252.4
NG COMBINED CYCLE	CAPACITY...	4.45	4.45	4.45	4.45	4.45	4.45	4.45
	GENERATION.	12.7	16.7	19.0	18.5	19.5	24.5	27.6
OIL COMBINED CYCLE	CAPACITY...	3.34	3.49	3.49	3.49	3.49	3.49	3.49
	GENERATION.	2.3	8.6	8.8	9.0	10.4	9.9	10.9
NATURAL GAS TURBINE	CAPACITY...	4.64	5.06	5.06	5.06	5.06	5.06	5.06
	GENERATION.	5.3	1.7	2.2	3.6	4.4	5.8	7.3
OIL TURBINE	CAPACITY...	46.51	48.09	48.20	48.28	48.34	48.51	48.58
	GENERATION.	5.6	13.8	14.9	12.9	14.9	16.8	21.5
NG/OIL TURBINE	CAPACITY...	52.62	52.68	52.68	52.68	52.68	52.68	52.68
	GENERATION.	8.1	7.4	7.7	7.8	9.5	11.5	14.4
NUCLEAR	CAPACITY...	50.18	77.94	88.30	99.06	106.37	112.76	113.93
	GENERATION.	251.0	387.1	439.7	493.8	543.5	574.8	595.1
PUMP STORAGE HYDRO(1)	CAPACITY...	88.20	14.25	15.82	18.66	19.50	20.28	20.54
	GENERATION.	282.0	12.8	16.2	20.1	23.2	27.7	33.0
PONDAGE HYDRO(1)	CAPACITY...	--	72.05	72.44	72.52	72.65	72.85	72.92
	GENERATION.	--	302.7	304.2	304.6	306.1	307.8	310.3
DOMESTIC TOTAL	CAPACITY...	642.08	721.48	742.87	761.60	778.02	793.64	805.93
	GENERATION.	2287.6	2592.9	2692.3	2779.7	2881.1	2971.2	3083.3
CANADIAN IMPORTS	GENERATION.	26.72	94.29	96.73	98.98	101.32	104.01	107.10

(1) IN 1980, PONDAGE HYDROPOWER IS INCLUDED IN PUMP STORAGE HYDROPOWER.
--=NOT APPLICABLE.
NOTE: "CAPACITY" INDICATES THE POTENTIAL AMOUNT OF ELECTRICAL POWER THAT COULD BE GENERATED IF POWERPLANTS OPERATED NONSTOP.
NOTE: "GENERATION" INDICATES THE AMOUNT OF ELECTRICITY PRODUCED FROM EACH CAPACITY TYPE.
NOTE: ENTRIES FOR 1980 ARE A COMBINATION OF HISTORICAL AND ESTIMATED VALUES.
SOURCES: ON PAGE 222. SEE 10, PP 273-287, TABLE 9; AND 11, PAGE 1, TABLE 1.

TABLE A.5.4. SCHEDULED ELECTRIC UTILITY CAPACITY ADDITIONS
CASE A: MIDDLE WORLD OIL PRICE
(CAPACITY IN MEGAWATTS)

NEW CAPACITY TYPE	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	TOTAL
COAL STEAM.........	13633.	9499.	9821.	7623.	8888.	10524.	4918.	6198.	7753.	9537.	9269.	96261.
OIL STEAM..........	987.	1895.	0.	0.	0.	10.	0.	0.	50.	0.	0.	2942.
NG/COAL STEAM......	570.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	570.
OIL CC.............	0.	0.	90.	60.	0.	0.	0.	0.	0.	0.	0.	150.
NG TURBINE.........	76.	375.	8.	0.	0.	0.	0.	0.	0.	0.	0.	459.
OIL TURBINE........	978.	238.	230.	320.	82.	154.	73.	97.	54.	140.	94.	2460.
NG/OIL TURBINE.....	0.	60.	0.	0.	0.	0.	0.	0.	0.	0.	0.	60.
NUCLEAR............	1819.	3912.	3296.	5250.	9269.	9183.	14455.	4910.	10063.	2355.	0.	64512.
PUMP STORAGE.......	256.	0.	997.	531.	0.	1050.	2050.	2325.	0.	955.	150.	8314.
PONDAGE HYDRO......	1373.	259.	772.	923.	679.	482.	187.	103.	232.	74.	0.	5083.
TOTAL NEW CAPACITY	19692.	16237.	15214.	14107.	18118.	21403.	21683.	13633.	18152.	13061.	9513.	180806.

SOURCES: ON PAGE 222. SEE 10, PP 27-259, TABLE 7; AND 10, PP 273-287, TABLE 9.

TABLE A.5.5. SUMMARY OF COMPLNENTS OF ELECTRICITY PRICE
CASE A: MIDDLE WORLD OIL PRICE
(1982 MILLS PER KWH)

	1980	1985	1986	1987	1988	1989	1990
PRIVATE UTILITIES							
CAPITAL COMPONENT...	10.21	10.16	10.45	10.30	10.47	10.19	9.83
FUEL COMPONENT......	26.14	26.67	27.98	29.10	29.71	30.08	30.77
O&M COMPONENT(1)....	8.33	8.70	8.72	8.73	8.70	8.67	8.57
OTHERS(2)...........	12.22	11.49	11.65	12.38	12.05	12.19	12.15
TOTAL PRICE.........	56.90	57.02	58.81	60.51	60.93	61.13	61.33
PUBLIC & PRIVATE UTILITIES							
CAPITAL COMPONENT...	10.51	10.64	10.79	10.61	10.63	10.30	10.01
FUEL COMPONENT......	25.32	25.64	26.93	28.01	28.71	29.15	29.92
O&M COMPONENT(1)....	8.06	8.44	8.45	8.47	8.43	8.41	8.31
OTHERS(2)...........	10.67	10.07	10.25	10.94	10.68	10.79	10.72
TOTAL PRICE.........	54.56	54.79	56.43	58.03	58.45	58.64	58.96

(1) OPERATION AND MAINTENANCE.
(2) INCLUDES DEPRECIATION AND TAXES.
NOTE: ENTRIES FOR 1980 ARE A COMBINATION OF HISTORICAL AND ESTIMATED VALUES.

TABLE A.6.1. ANNUAL SUPPLY AND DISPOSITION OF PETROLEUM
CASE A: MIDDLE WORLD OIL PRICE
(MILLIONS OF BARRELS PER DAY)

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
SUPPLY											
PRODUCTION											
CRUDE OIL	8.60	8.57	8.67	8.64	8.77	8.79	8.85	8.84	8.80	8.66	8.21
NORTH SLOPE	1.52	1.53	1.61	1.63	1.70	1.71	1.78	1.78	1.78	1.82	1.73
SUBARCTIC(1)	7.08	7.05	7.06	7.00	7.05	7.04	6.98	6.93	6.84	6.60	6.19
NATURAL GAS LIQUIDS	1.57	1.61	1.55	1.54	1.36	1.21	1.17	1.17	1.22	1.26	1.30
OTHER DOMESTIC(2)	0.04	0.05	0.05	0.05	0.02	0.04	0.09	0.14	0.19	0.24	0.29
PROCESSING GAIN	0.60	0.51	0.53	0.49	0.53	0.57	0.57	0.55	0.56	0.54	0.54
TOTAL PRODUCTION	10.81	10.74	10.81	10.72	10.66	10.57	10.59	10.57	10.57	10.46	10.04
IMPORTS(3)											
CRUDE OIL	5.26	4.40	3.46	3.75	5.17	6.35	6.21	5.89	5.60	5.45	5.86
REFINED PRODUCTS(4)	1.65	1.60	1.58	1.76	2.03	2.10	2.11	2.10	2.09	2.08	2.10
TOTAL IMPORTS	6.91	6.00	5.04	5.51	7.20	8.45	8.32	7.99	7.69	7.53	7.96
EXPORTS											
CRUDE OIL	0.29	0.23	0.24	0.23	0.25	0.25	0.25	0.25	0.25	0.25	0.25
REFINED PRODUCTS(4)	0.26	0.37	0.58	0.55	0.62	0.62	0.62	0.62	0.62	0.62	0.62
TOTAL EXPORTS	0.54	0.59	0.82	0.78	0.87	0.87	0.87	0.87	0.87	0.87	0.87
NET IMPORTS	6.37	5.40	4.23	4.72	6.33	7.58	7.45	7.12	6.82	6.66	7.09
PRIMARY STOCK CHANGES(5)											
NET WITHDRAWALS	-0.09	0.18	0.32	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SPR FILL RATE ADDITIONS(6)	-0.05	-0.34	-0.17	-0.21	-0.15	-0.15	-0.15	-0.15	-0.15	-0.15	-0.15
TOTAL PRIMARY SUPPLY	17.04	15.98	15.18	15.37	16.84	18.00	17.89	17.54	17.24	16.97	16.98
PRODUCT SUPPLIED											
MOTOR GASOLINE	6.86	6.59	6.54	6.36	6.54	6.42	6.11	5.79	5.49	5.29	5.15
DISTILLATE FUEL OIL	2.97	2.83	2.67	2.75	3.19	3.57	3.66	3.61	3.60	3.61	3.69
RESIDUAL FUEL OIL	2.56	2.09	1.69	1.73	2.57	3.23	3.30	3.30	3.26	3.14	3.12
OTHER PRODUCTS(7)	5.11	4.83	4.66	4.83	4.98	5.10	5.15	5.17	5.19	5.24	5.34
TOTAL RECLASSIFIED(8)	-0.44	-0.27	-0.31	-0.30	-0.30	-0.32	-0.32	-0.31	-0.31	-0.30	-0.30
TOTAL PRODUCT SUPPLIED	17.06	16.06	15.25	15.37	16.84	18.00	17.89	17.55	17.24	16.98	16.99
DISCREPANCY	-0.02	-0.08	-0.07	0.00	-0.00	-0.00	-0.00	-0.01	-0.00	-0.01	-0.01
NET DISPOSITION	17.04	15.98	15.18	15.37	16.84	18.00	17.89	17.54	17.24	16.97	16.98

(1) INCLUDES LOWER-48 STATES AND SOUTHERN ALASKA.
(2) OTHER DOMESTIC REPRESENTS OTHER HYDROCARBON INPUT.
(3) INCLUDES IMPORTS FOR THE STRATEGIC PETROLEUM RESERVE.
(4) CONSISTS OF NATURAL GAS PLANT LIQUIDS, UNFINISHED OILS, AND REFINED PRODUCT IMPORTS.
(5) EXCLUDES CRUDE OIL FOR THE STRATEGIC PETROLEUM RESERVE.
(6) ADDITIONS TO THE STRATEGIC PETROLEUM RESERVE (SHOWN AS NEGATIVE ENTRIES).
(7) COMPOSED OF JET FUEL, LIQUEFIED GASES, AND OTHER PRODUCTS.
(8) PETROLEUM PRODUCTS REPROCESSED INTO OTHER PRODUCT CATEGORIES.

NOTE: IN 1980, GASOLINE SUPPLIED HAS BEEN ADJUSTED TO CORRECT UNDERESTIMATION OF PRODUCT SUPPLIED. DISTILLATE AND RESIDUAL FUEL OIL HAVE BEEN RESTATED INTO THE NEW BASIS FOR COMPARABILITY PURPOSES.

NOTE: ENTRIES FOR 1980 ARE A COMBINATION OF HISTORICAL AND ESTIMATED VALUES.

SOURCES: ON PAGE 222, SEE 4, PAGE 6, TABLE 1; AND 20, PAGE 18, TABLE 7.

TABLE A.7.1. NATURAL GAS SUPPLY/DEMAND BALANCE
CASE A: MIDDLE WORLD OIL PRICE
(TRILLION BTU PER YEAR; 1982 DOLLARS PER MILLION BTU)

	1980	1985	1986	1987	1988	1989	1990
LOWER-48 ONSHORE SUPPLY	14435.	11270.	10674.	10566.	11159.	11839.	12679.
LOWER-48 OFFSHORE SUPPLY	5477.	3911.	4016.	4189.	4173.	4015.	3680.
TOTAL DOMESTIC SUPPLY	19912.	15181.	14690.	14755.	15332.	15854.	16359.
CATEGORY 102 (NEW GAS)	3439.	6187.	6619.	7342.	8267.	9307.	10009.
CATEGORY 104 (OLD INTERSTATE GAS)	8910.	5730.	4980.	4360.	3850.	3440.	3090.
CATEGORY 105 (OLD INTRASTATE GAS)	6899.	3050.	2750.	2550.	2370.	2110.	2000.
CATEGORY 107 (DEEP GAS)	664.	214.	341.	503.	845.	997.	1259.
SUPPLEMENTAL GAS(1)	159.	0.	272.	208.	0.	0.	0.
IMPORTS	957.	1230.	1230.	1230.	1230.	1230.	1230.
TOTAL SUPPLY	21028.	16411.	16192.	16193.	16562.	17084.	17589.
LEASE AND PLANT FUEL(2)	1045.	1139.	1102.	1107.	1150.	1189.	1227.
TRANSPORTATION LOSS(3)	647.	1054.	1047.	1045.	1062.	1097.	1124.
CONSUMPTION BY SECTOR							
RESIDENTIAL	4866.	4585.	4521.	4463.	4413.	4375.	4344.
COMMERCIAL(4)	2674.	2723.	2692.	2644.	2587.	2542.	2500.
REFINERY	846.	298.	280.	289.	325.	350.	380.
ELECTRIC UTILITY	3807.	1701.	1719.	1748.	1868.	2180.	2394.
INDUSTRIAL(5)	6497.	4907.	4831.	4896.	5158.	5352.	5620.
TOTAL END-USE CONSUMPTION	18690.	14213.	14044.	14040.	14350.	14799.	15238.
DISCREPANCY(6)	-646.	0.	0.	0.	0.	0.	0.
WELLHEAD PRICES							
AVERAGE PRICE	1.79	3.68	4.31	4.93	5.18	5.18	5.17
CATEGORY 102 (NEW GAS)	2.69	4.55	5.39	5.95	6.05	5.91	5.79
CATEGORY 104 (OLD INTERSTATE GAS)	1.32	2.12	2.33	2.59	2.64	2.63	2.60
CATEGORY 105 (OLD INTRASTATE GAS)	1.67	4.35	5.13	5.83	5.94	5.81	5.70
CATEGORY 107 (DEEP GAS)	4.78	4.55	5.39	5.95	6.05	5.91	5.79
DELIVERED PRICE BY SECTOR							
RESIDENTIAL	4.16	6.65	7.43	8.01	8.28	8.35	8.53
COMMERCIAL(4)	3.84	6.42	7.24	7.85	8.14	8.27	8.40
REFINERY	3.08	4.75	5.58	6.06	6.21	6.24	6.25
ELECTRIC UTILITY	2.88	5.54	6.43	7.00	7.02	7.13	7.19
INDUSTRIAL(5)	2.98	5.62	6.45	7.00	7.13	7.17	7.23

(1) INCLUDES INCREASED GAS OR OIL IMPORTS.
(2) REPRESENTS GAS USED AS A FUEL IN FIELD GATHERING AND PLANT PROCESSING MACHINERY.
(3) INDICATES GAS USED TO FUEL COMPRESSORS IN THE PIPELINE MACHINERY.
(4) COMMERCIAL IS AN AGGREGATE OF COMMERCIAL AND OTHER CATEGORIES.
(5) EXCLUDES LEASE AND PLANT FUEL CONSUMPTION.
(6) REPRESENTS IMBALANCES RESULTING FROM THE MERGER OF DATA REPORTING SYSTEMS WHICH VARY IN SCOPE, FORMAT, DEFINITIONS AND TYPE OF RESPONDANTS.

NOTE: ENTRIES FOR 1980 ARE A COMBINATION OF HISTORICAL AND ESTIMATED VALUES.

SOURCES: ON PAGE 222, SEE 1, PP 15-19; 12, PAGE 7, TABLE 1; 13, PAGE 133, TABLE A7.

TABLE A.8.1. COAL SUPPLY AND DISPOSITION
CASE A: MEDIUM WORLD OIL PRICE
(MILLIONS OF SHORT TONS PER YEAR)

	1980	1985	1986	1987	1988	1989	1990
DOMESTIC SUPPLY							
EASTERN..............	579.	604.	619.	631.	648.	667.	692.
WESTERN..............	251.	310.	320.	332.	347.	364.	388.
NET IMPORTS(1).......	-91.	-109.	-114.	-120.	-127.	-135.	-144.
STOCK WITHDRAWALS....	-36.	0.	0.	0.	0.	0.	0.
TOTAL SUPPLY..........	703.	805.	825.	843.	868.	896.	936.
CONSUMPTION							
RESIDENTIAL/COMM.....	7.	7.	7.	7.	7.	6.	6.
INDUSTRIAL...........	60.	76.	78.	81.	85.	86.	93.
METALLURGICAL........	67.	49.	50.	50.	51.	51.	52.
ELECTRIC UTILITY.....	569.	667.	685.	700.	720.	744.	780.
SYNTHETIC USE........	0.	5.	5.	5.	5.	5.	5.
TOTAL CONSUMPTION.....	703.	805.	825.	843.	868.	896.	936.
TOTAL DISPOSITION.....	703.	805.	825.	843.	868.	896.	936.

(1) EXPORTS TO EUROPE AND JAPAN.

NOTE: EASTERN INCLUDES PENSYLVANIA, OHIO, MARYLAND, WEST VIRGINIA, VIRGINIA, KENTUCKY, TENNESSEE, ALABAMA, ILLINOIS, AND INDIANA. WESTERN INCLUDES IOWA, MISSOURI, KANSAS, ARKANSAS, OKLAHOMA, TEXAS, NORTH DAKOTA, SOUTH DAKOTA, MONTANA, WYOMING, COLORADO, UTAH, ARIZONA, NEW MEXICO, WASHINGTON, AND ALASKA.

NOTE: ENTRIES FOR 1980 ARE HISTORICAL DATA, AND STOCK WITHDRAWALS INCLUDES DISCREPANCY.

Case B
Low World Oil Price Forecast

Of all the underlying assumptions, perhaps the greatest amount of uncertainty surrounds the world oil price. Since 1973, the petroleum market has experienced two major price shocks--the first resulting from the OPEC oil embargo in 1973-1974 and the second following the Iranian revolution in 1979. Because the energy projections are highly dependent on the assumed path of future oil prices, two additional price paths were examined.

The middle world oil forecast (Case A) assumed that the real price of oil (in 1982 dollars) delivered to the United States will decrease from $34 per barrel in 1982 to $25 per barrel in 1985, and then increase to $37 per barrel by 1990 (see Table 1.4). In the low world oil price case B, the cost of imported oil is assumed to decline to $21 per barrel in 1985 (see Table B.1.4). It does not begin to rise again until 1987, and it subsequently increases to $28 per barrel by 1990. In the high price case C, the oil price decreases until 1984, then increases to $34 per barrel in 1985 and rises rapidly thereafter. By 1990, the "high" world oil price is $48 per barrel.

Lower world oil price (Case B scenario) would increase total energy consumption. In 1985, total consumption is projected to be about 2 percent higher than in the midprice case (see Table A.1.1). The incremental energy demand would be met by oil imports (crude plus products), which would increase by about 14 percent. The additional oil imports would also replace domestic supplies of oil and natural gas, both of which would decline slightly.

The substitution of imported oil for domestic oil and natural gas would intensify through 1990. Oil imports in the low case are projected to be about 33 percent higher than in the midprice case, while domestic oil production would decrease by 1.1 quadrillion Btu, and domestic natural gas supply would decline by approximately 7 percent.

THE FOLLOWING SECTION OF TABLES ARE FOR THE:

CASE B: LOW WORLD OIL PRICE

THIS SECTION CONTAINS THE FOLLOWING TABLES:

EXECUTIVE SUMMARY TABLES
- TABLE B.1.1. YEARLY SUPPLY AND DISPOSITION OF TOTAL ENERGY
- TABLE B.1.2. SUPPLY/DEMAND BALANCE
- TABLE B.1.3. CONSUMPTION SUMMARY
- TABLE B.1.4. PRICE SUMMARY

MACROECONOMIC TABLE
- TABLE B.3.1. NATIONAL MACROECONOMIC INDICATORS

END-USE CONSUMPTION TABLES
- TABLE B.4.1. RESIDENTIAL SECTOR FUEL CONSUMPTION BY END-USE SERVICE
- TABLE B.4.2. COMMERCIAL SECTOR ENERGY CONSUMPTION AND FLOORSPACE BY BUILDING CATEGORY
- TABLE B.4.3. INDUSTRIAL SECTOR ENERGY CONSUMPTION
- TABLE B.4.4. TRANSPORTATION SECTOR ENERGY CONSUMPTION BY MODE

ELECTRIC UTILITY TABLES
- TABLE B.5.1. ELECTRIC UTILITY FUEL PRICES AND CONSUMPTION
- TABLE B.5.2. END-USE ELECTRICITY PRICES AND CONSUMPTION
- TABLE B.5.3. ELECTRIC UTILITY CAPACITY AND GENERATION
- TABLE B.5.4. SCHEDULED ELECTRIC UTILITY CAPACITY ADDITIONS
- TABLE B.5.5. SUMMARY OF COMPONENTS OF ELECTRICITY PRICE

PETROLEUM SUPPLY TABLE
- TABLE B.6.1. ANNUAL SUPPLY AND DISPOSITION OF PETROLEUM

NATURAL GAS SUPPLY TABLE
- TABLE B.7.1. NATURAL GAS SUPPLY/DEMAND BALANCE

COAL SUPPLY TABLE
- TABLE B.8.1. COAL SUPPLY AND DISPOSITION

TABLE B.1.1. YEARLY SUPPLY AND DISPOSITION OF TOTAL ENERGY
CASE B: LOW WORLD OIL PRICE
(QUADRILLION BTU PER YEAR)

	1975	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
SUPPLY												
PRODUCTION												
PETROLEUM..........	20.1	20.5	20.4	20.6	20.5	20.4	20.1	19.9	19.6	19.4	19.1	18.2
NATURAL GAS........	19.6	20.1	19.9	18.2	17.5	16.9	14.9	14.2	14.0	14.3	14.8	15.3
COAL...............	15.2	19.2	19.1	19.1	19.4	19.4	20.3	20.8	21.3	21.9	22.7	23.7
NUCLEAR............	1.9	2.7	2.9	3.0	3.2	3.7	4.1	4.7	5.3	5.8	6.1	6.3
HYDRO/GEO/OTHER....	3.2	3.0	2.9	3.3	3.2	3.1	3.1	3.1	3.2	3.2	3.2	3.2
SUBTOTAL.........	60.1	65.5	65.2	64.2	63.7	63.5	62.5	62.7	63.2	64.5	65.8	66.8
NET IMPORTS												
CRUDE OIL..........	8.7	10.6	8.8	6.8	7.5	11.6	15.2	16.1	16.3	16.1	15.9	16.7
OTHER PETROLEUM....	3.8	2.9	2.6	2.1	2.5	3.0	3.2	3.3	3.4	3.4	3.3	3.4
NG (CONTRACTED)(1).	0.9	1.0	.9	.9	1.1	1.2	1.2	1.2	1.2	1.2	1.2	1.2
OTHER GAS(2).......	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.6	0.8	0.7	0.4	0.0
COAL AND COKE......	-1.7	-2.4	-2.9	-2.8	-2.6	-2.7	-2.9	-3.0	-3.2	-3.4	-3.6	-3.8
ELECTRICITY........	0.1	.2	.2	.2	.2	0.3	0.3	0.3	0.3	0.3	0.4	0.4
SUBTOTAL.........	11.7	12.3	9.6	7.3	8.6	13.4	17.2	18.6	18.9	18.4	17.6	18.0
SPR ADDITIONS(3)....	0.0	-.1	-.7	-.4	-.4	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3
STOCK WITHDRAWALS...	-1.1	-1.8	0.0	-.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL SUPPLY.........	70.7	75.9	74.1	70.9	71.9	76.6	79.4	81.0	81.8	82.6	83.1	84.4
CONSUMPTION												
NON-ELEC UTILITY FUEL												
PETROLEUM..........	29.5	31.5	29.9	28.6	29.2	31.6	33.8	34.5	34.4	34.0	33.4	33.3
NATURAL GAS(4).....	16.7	16.6	16.1	15.0	14.9	14.4	13.6	13.4	13.4	13.6	13.7	13.9
COAL...............	4.0	3.4	3.4	3.0	2.9	3.2	3.3	3.3	3.4	3.4	3.5	3.6
SUBTOTAL.........	50.2	51.4	49.4	46.4	47.0	49.2	50.7	51.3	51.2	51.0	50.6	50.8
ELECTRIC UTILITY FUEL												
PETROLEUM..........	3.2	2.7	2.2	1.8	1.5	3.0	4.3	4.5	4.5	4.6	4.7	4.9
NATURAL GAS........	3.2	3.8	3.8	3.3	3.4	2.6	1.6	1.6	1.6	1.7	1.7	1.7
COAL...............	8.8	12.1	12.7	12.7	13.2	13.5	14.1	14.5	14.7	15.1	15.6	16.3
NUCLEAR............	1.9	2.7	2.9	3.0	3.2	3.7	4.1	4.7	5.3	5.8	6.1	6.3
HYDRO/GEO/OTHER(5).	3.4	3.2	3.1	3.5	3.4	3.4	3.5	3.5	3.5	3.5	3.5	3.6
SUBTOTAL.........	20.5	24.5	24.7	24.3	24.7	26.0	27.3	28.4	29.3	30.4	31.3	32.4
TOTAL CONSUMPTION....	70.7	75.9	74.1	70.7	71.7	75.2	78.0	79.7	80.5	81.3	81.9	83.2
ADJUSTMENTS												
REFINERY LOSSES(6).	0.0	0.0	0.0	0.0	-0.1	0.0	0.2	0.2	0.2	0.3	0.3	0.3
DISCREPANCY(7).....	0.0	0.0	0.0	0.2	0.3	1.4	1.2	1.1	1.1	1.0	0.9	0.9
TOTAL DISPOSITION....	70.7	75.9	74.1	70.9	71.9	76.6	79.4	81.0	81.8	82.6	83.1	84.4

NOTE: THE "ANNUAL ENERGY REVIEW" FOR 1982 WILL CONTAIN LATER REVISIONS TO HISTORICAL DATA FOR 1975, 1980 AND 1982.
NOTE: TOTALS MAY NOT EQUAL SUM OF COMPONENTS DUE TO INDEPENDENT ROUNDING. FOR TABLE FOOTNOTES AND SOURCES SEE PAGE 219.

TABLE B.1.2. SUPPLY/DEMAND BALANCE
CASE B: LOW WORLD OIL PRICE
(QUADRILLION BTU PER YEAR)

	1975	1980	1985	1986	1987	1988	1989	1990
DOMESTIC SUPPLY								
COAL	15.2	19.2	20.3	20.8	21.3	21.9	22.7	23.7
NATURAL GAS	19.6	19.9	14.9	14.2	14.0	14.3	14.8	15.3
PETROLEUM	20.1	20.5	20.1	19.9	19.6	19.4	19.1	18.2
NUCLEAR	1.9	2.7	4.1	4.7	5.3	5.8	6.1	6.3
OTHER(1)	3.2	3.0	3.1	3.1	3.2	3.2	3.2	3.2
TOTAL DOMESTIC SUPPLY	60.0	65.3	62.5	62.7	63.2	64.5	65.8	66.8
NATURAL GAS IMPORTS	0.9	1.0	1.2	1.2	1.2	1.2	1.2	1.2
SUPPLEMENTAL GAS(2)	0.0	0.2	0.1	0.6	0.8	0.7	0.4	0.0
PETROLEUM IMPORTS	12.5	13.5	18.4	19.5	19.6	19.5	19.2	20.1
TOTAL SUPPLY(3)	73.4	80.0	82.2	84.0	84.9	85.9	86.6	88.2
DISPOSITION								
RESIDENTIAL	9.6	9.3	9.3	9.4	9.4	9.5	9.6	9.6
COMMERCIAL	5.5	5.9	6.7	6.8	7.0	7.0	7.1	7.2
INDUSTRIAL(4)	21.3	23.0	23.1	23.8	24.2	24.6	24.7	25.3
TRANSPORTATION	17.7	19.7	19.3	19.3	18.9	18.5	18.1	17.9
TOTAL END-USE CONSUMPTION	54.1	57.9	58.3	59.3	59.5	59.6	59.4	59.9
DISCREPANCY	0.2	-0.1	-0.1	-0.1	-0.2	-0.3	-0.4	-0.4
ADJUSTMENTS	19.1	22.2	24.0	24.8	25.6	26.6	27.6	28.7
UTILITY GENERATION	13.7	16.5	18.4	19.1	19.7	20.4	21.0	21.7
UTILITY TRANSMISSION	0.6	0.7	0.9	0.9	0.9	1.0	1.0	1.0
REFINERY(5)	0.0	0.0	0.2	0.2	0.2	0.3	0.3	0.3
GAS PIPELINE(6)	0.6	0.6	1.0	1.0	1.0	1.0	1.0	1.1
LEASE/PLANT FUEL(7)	1.4	1.0	1.1	1.1	1.0	1.1	1.1	1.2
COAL EXPORTS	1.7	2.4	2.9	3.0	3.2	3.4	3.6	3.8
SPR ADDITIONS	0.0	0.1	0.3	0.3	0.3	0.3	0.3	0.3
STOCK WITHDRAWALS	1.1	1.8	0.0	0.0	0.0	0.0	0.0	0.0
RECLASSIFIED	0.0	-0.9	-0.7	-0.7	-0.7	-0.7	-0.7	-0.7
ADJUSTED CONSUMPTION	73.4	80.0	82.2	84.0	84.9	85.9	86.6	88.2
ELECTRIC UTILITY FUEL								
COAL	8.8	12.1	14.1	14.5	14.7	15.1	15.6	16.3
PETROLEUM	3.2	2.7	4.3	4.5	4.5	4.6	4.7	4.9
NATURAL GAS	3.2	3.8	1.6	1.6	1.6	1.7	1.7	1.7
TOTAL FOSSIL	15.2	18.6	20.1	20.6	20.9	21.4	22.0	22.9
NUCLEAR	1.9	2.7	4.1	4.7	5.3	5.8	6.1	6.3
OTHER	3.2	3.0	3.1	3.1	3.2	3.2	3.2	3.2
TOTAL	20.3	24.3	27.3	28.4	29.3	30.4	31.3	32.4
GENERATION	6.6	7.8	9.0	9.3	9.6	10.0	10.3	10.7

NOTE: TOTALS MAY NOT EQUAL SUM OF COMPONENTS DUE TO INDEPENDENT ROUNDING. FOR TABLE FOOTNOTES AND SOURCES SEE PAGE 219.

TABLE B.1.3. CONSUMPTION SUMMARY
CASE B: LOW WORLD OIL PRICE
(QUADRILLION BTU PER YEAR)

	1975	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
RESIDENTIAL	9.571	9.335	9.104	9.236	9.143	9.208	9.281	9.370	9.446	9.506	9.553	9.594
STEAM COAL.............	0.091	0.065	0.080	0.082	0.071	0.078	0.076	0.074	0.073	0.071	0.069	0.068
NATURAL GAS............	5.022	4.866	4.654	4.793	4.710	4.652	4.594	4.545	4.501	4.468	4.424	4.391
DISTILLATE(1)..........	1.923	1.417	1.375	1.303	1.230	1.329	1.369	1.409	1.438	1.455	1.459	1.458
LIQUID PETROLEUM GAS...	0.528	0.539	0.536	0.570	0.590	0.572	0.592	0.611	0.625	0.632	0.635	0.635
ELECTRICITY	2.007	2.448	2.459	2.488	2.530	2.577	2.649	2.730	2.810	2.888	2.966	3.042
COMMERCIAL	5.513	5.892	5.818	5.866	6.182	6.467	6.666	6.833	6.950	7.026	7.109	7.189
STEAM COAL.............	0.135	0.095	0.107	0.122	0.086	0.097	0.095	0.093	0.091	0.088	0.086	0.083
NATURAL GAS............	2.559	2.674	2.580	2.683	2.720	2.736	2.736	2.718	2.683	2.636	2.594	2.553
DISTILLATE(1)..........	0.622	0.556	0.540	0.511	0.670	0.749	0.800	0.848	0.888	0.917	0.941	0.959
LO-SULFUR RESIDUAL.....	0.506	0.566	0.470	0.376	0.490	0.550	0.587	0.623	0.652	0.674	0.691	0.704
LIQUID PETROLEUM GAS...	0.093	0.095	0.095	0.101	0.090	0.080	0.078	0.077	0.075	0.073	0.071	0.069
ELECTRICITY	1.598	1.906	2.026	2.074	2.150	2.254	2.370	2.475	2.563	2.639	2.726	2.821
INDUSTRIAL(2)	18.503	20.185	19.513	16.876	17.365	19.219	20.349	21.059	21.413	21.849	21.998	22.582
STEAM COAL.............	1.619	1.388	1.570	1.626	1.501	1.766	1.791	1.829	1.873	1.935	2.007	2.094
METALLURGICAL COAL.....	2.178	1.793	1.647	1.057	1.132	1.263	1.304	1.327	1.340	1.355	1.360	1.375
NATURAL GAS............	6.133	6.497	6.639	5.414	5.340	5.314	4.891	4.835	4.920	5.124	5.235	5.425
DISTILLATE.............	1.272	1.569	1.285	1.212	1.340	1.916	2.606	2.857	2.833	2.739	2.588	2.533
LO-SULFUR RESIDUAL.....	0.428	0.554	0.423	0.367	0.390	0.511	0.609	0.653	0.663	0.669	0.655	0.671
HI-SULFUR RESIDUAL.....	0.856	0.713	0.531	0.484	0.530	0.760	0.965	1.058	1.079	1.076	1.042	1.053
LIQUID PETROLEUM GAS...	0.252	0.308	0.323	0.332	0.370	0.375	0.411	0.400	0.353	0.301	0.245	0.205
PET-CHEM FEEDSTOCK(3)..	1.519	2.401	2.111	1.862	1.980	2.219	2.380	2.521	2.635	2.748	2.839	2.990
OTHER(4)...............	1.900	2.180	2.166	1.977	2.240	2.249	2.332	2.374	2.392	2.404	2.410	2.434
ELECTRICITY	2.346	2.781	2.817	2.545	2.620	2.846	3.061	3.205	3.326	3.498	3.617	3.803
TRANSPORTATION(5)	17.725	19.655	18.715	18.129	17.910	18.922	19.307	19.267	18.935	18.491	18.091	17.893
DISTILLATE.............	2.069	2.782	2.738	2.582	2.510	2.802	2.932	3.026	3.109	3.179	3.256	3.359
HI-SULFUR RESIDUAL.....	0.731	1.401	1.163	0.930	0.900	1.023	1.077	1.115	1.145	1.166	1.186	1.215
GASOLINE(6)............	12.868	13.253	12.688	12.528	12.180	12.802	12.891	12.633	12.119	11.537	10.992	10.613
JET FUEL(7)............	2.029	2.179	2.087	2.049	2.280	2.255	2.368	2.453	2.522	2.569	2.616	2.665
LIQUID PETROLEUM GAS...	0.016	0.014	0.014	0.015	0.020	0.015	0.015	0.015	0.015	0.015	0.015	0.015
OTHER..................	0.000	0.014	0.014	0.014	0.010	0.014	0.014	0.014	0.014	0.014	0.014	0.014
ELECTRICITY	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010
ELECTRIC UTILITY FUEL	20.368	24.243	24.462	24.203	24.480	25.973	27.325	28.383	29.289	30.354	31.278	32.442
STEAM COAL.............	8.790	12.122	12.707	12.697	13.190	13.531	14.133	14.453	14.709	15.090	15.575	16.264
NATURAL GAS............	3.240	3.807	3.764	3.336	3.440	2.631	1.598	1.625	1.643	1.679	1.705	1.746
DISTILLATE(8)..........	0.350	0.121	0.077	0.048	0.090	0.216	0.496	0.568	0.575	0.652	0.702	0.835
LO-SULFUR RESIDUAL(9)..	2.860	1.611	1.251	0.980	0.780	1.853	2.646	2.694	2.725	2.741	2.751	2.785
HI-SULFUR RESIDUAL.....	NA	0.922	0.898	0.789	0.600	0.955	1.201	1.215	1.231	1.243	1.236	1.255
HYDRO/GEO/OTHER(10)....	3.220	2.988	2.864	3.340	3.190	3.115	3.133	3.149	3.153	3.169	3.194	3.227
NUCLEAR................	1.900	2.672	2.901	3.013	3.190	3.671	4.118	4.678	5.253	5.782	6.114	6.331
REFINERY FUEL(11)	2.769	2.787	2.304	2.190	2.480	2.434	2.715	2.786	2.776	2.741	2.692	2.687
NATURAL GAS............	0.975	0.846	0.668	0.574	0.720	0.407	0.251	0.216	0.216	0.236	0.260	0.284
DISTILLATE.............	0.035	0.018	0.011	0.011	0.010	0.012	0.014	0.014	0.014	0.014	0.013	0.013
LO-SULFUR RESIDUAL.....	NA	NA	NA	NA	0.090	0.130	0.177	0.191	0.189	0.183	0.173	0.170
HI-SULFUR RESIDUAL.....	0.269	0.213	0.167	0.137	0.200	0.341	0.552	0.598	0.596	0.571	0.539	0.516
LIQUID PETROLEUM GAS...	0.050	0.043	0.024	0.038	0.030	0.026	0.029	0.030	0.030	0.030	0.029	0.029
OTHER(12)..............	0.390	0.436	0.359	0.348	0.360	0.378	0.421	0.432	0.431	0.425	0.418	0.417
STILL GAS..............	1.050	1.231	1.073	1.085	1.080	1.139	1.271	1.304	1.299	1.283	1.260	1.258

NOTE: TOTALS MAY NOT EQUAL SUM OF COMPONENTS DUE TO INDEPENDENT ROUNDING. FOR TABLE FOOTNOTES AND SOURCES SEE PAGE 219.

TABLE B.1.4. PRICE SUMMARY
CASE B: LOW WORLD OIL PRICE
(1982 DOLLARS PER MILLION BTU)

	1975	1980	1985	1986	1987	1988	1989	1990
WORLD OIL PRICE.........	20.70	39.32	21.08	20.99	22.30	24.00	26.20	27.60
RESIDENTIAL	5.95	8.33	9.05	9.41	9.81	10.16	10.54	10.91
NATURAL GAS...........	2.75	4.16	6.39	6.89	7.28	7.64	7.95	8.33
DISTILLATE(1)..........	4.75	8.59	5.24	5.22	5.54	5.95	6.49	6.84
LIQUID PETROLEUM GAS..	4.11	6.67	5.33	5.45	5.79	6.20	6.68	7.06
ELECTRICITY	15.61	16.78	16.66	16.84	17.12	17.21	17.41	17.58
COMMERCIAL	6.27	8.38	9.56	9.91	10.30	10.64	11.06	11.44
NATURAL GAS...........	2.17	3.84	6.16	6.69	7.12	7.50	7.87	8.27
DISTILLATE(1)..........	4.30	8.06	4.96	4.94	5.24	5.64	6.15	6.48
LO-SULFUR RESIDUAL....	4.13	5.32	4.11	4.17	4.44	4.80	5.24	5.60
LIQUID PETROLEUM GAS..	NA	6.67	5.34	5.46	5.80	6.21	6.69	7.07
ELECTRICITY	15.55	17.21	16.83	17.00	17.28	17.41	17.65	17.83
INDUSTRIAL(2)	3.37	5.44	5.87	6.03	6.33	6.63	7.00	7.29
STEAM COAL............	1.81	1.55	2.10	2.13	2.16	2.19	2.23	2.31
METALLURGICAL COAL....	2.80	2.51	2.56	2.59	2.61	2.63	2.66	2.72
NATURAL GAS...........	1.49	2.90	5.33	5.85	6.22	6.45	6.75	7.00
DISTILLATE............	4.24	7.99	4.87	4.86	5.15	5.55	6.05	6.38
LO-SULFUR RESIDUAL....	4.11	5.14	4.05	4.11	4.38	4.73	5.17	5.52
HI-SULFUR RESIDUAL....	2.93	NA	3.50	3.56	3.83	4.19	4.64	5.00
LIQUID PETROLEUM GAS..	3.83	6.34	5.16	5.27	5.60	6.00	6.45	6.81
PET-CHEM FEEDSTOCK(3).	NA	7.88	5.62	5.59	5.93	6.38	6.96	7.33
OTHER(4)..............	NA	NA	4.36	4.34	4.59	4.93	5.37	5.67
ELECTRICITY	9.42	11.67	13.75	13.91	14.18	14.28	14.47	14.65
TRANSPORTATION(5)	6.72	9.91	6.61	6.55	6.84	7.21	7.70	7.96
DISTILLATE............	5.85	8.39	5.18	5.16	5.48	5.89	6.43	6.78
HI-SULFUR RESIDUAL....	2.93	3.97	3.04	3.10	3.35	3.68	4.09	4.42
GASOLINE(6)...........	7.57	11.32	7.43	7.39	7.73	8.15	8.68	8.94
JET FUEL(7)...........	3.69	7.51	5.52	5.47	5.80	6.23	6.78	7.13
LIQUID PETROLEUM GAS..	NA	NA	5.10	5.22	5.55	5.95	6.41	6.78
ELECTRICITY	NA	NA	16.19	16.35	16.64	16.80	17.06	17.23
ELECTRIC UTILITY FUEL	2.04	1.84	1.95	1.99	2.05	2.11	2.19	2.28
STEAM COAL............	1.58	1.71	1.74	1.75	1.77	1.79	1.81	1.86
NATURAL GAS...........	1.14	2.80	5.23	5.80	6.19	6.34	6.66	6.83
DISTILLATE(8).........	3.28	7.22	4.88	4.87	5.17	5.56	6.07	6.40
LO-SULFUR RESIDUAL(9).	3.27	5.90	4.10	4.16	4.43	4.79	5.25	5.61
HI-SULFUR RESIDUAL....	NA	4.55	3.08	3.13	3.38	3.71	4.11	4.44
NUCLEAR...............	NA	.85	0.85	0.85	0.85	0.85	0.85	0.85
REFINERY FUEL	NA	NA	1.96	1.98	2.13	2.31	2.54	2.71
NATURAL GAS...........	NA	3.08	4.45	4.89	5.26	5.52	5.81	6.03
DISTILLATE............	NA	6.09	4.27	4.26	4.53	4.88	5.34	5.63
LO-SULFUR RESIDUAL....	NA	NA	3.54	3.59	3.84	4.16	4.56	4.89
HI-SULFUR RESIDUAL....	NA	4.89	2.88	2.94	3.18	3.51	3.90	4.23
LIQUID PETROLEUM GAS..	NA	NA	4.54	4.66	4.97	5.33	5.75	6.09
OTHER(10).............	NA	NA	4.24	4.23	4.48	4.82	5.26	5.55

NOTE: TOTALS MAY NOT EQUAL SUM OF COMPONENTS DUE TO INDEPENDENT ROUNDING. FOR TABLE FOOTNOTES AND SOURCES SEE PAGE 219.

TABLE B.3.1. NATIONAL MACROECONOMIC INDICATORS
CASE B: LOW WORLD OIL PRICE

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
REAL GROSS NATIONAL PRODUCT(1).....	2408.8	2455.6	2411.2	2445.9	2559.5	2673.9	2765.1	2853.2	2924.8	2999.0	3088.3
GROSS NATIONAL PRODUCT DEFLATOR(2).	1.0931	1.1964	1.2681	1.3293	1.3951	1.4672	1.5471	1.6434	1.7576	1.8790	2.0058
REAL GROWTH(3)....................	-0.41	1.98	-1.81	1.16	4.65	4.47	3.41	3.18	2.51	2.54	2.98
INFLATION(3)......................	9.31	9.45	5.99	7.17	4.95	5.17	5.45	6.22	6.95	6.91	6.74
REAL PERSONAL DISPOSABLE INCOME(1).	1663.6	1704.6	1723.3	1746.4	1829.5	1900.4	1962.2	2008.4	2042.0	2089.4	2140.9
UNEMPLOYMENT RATE(3)..............	7.1	7.6	9.7	10 62	9.52	8.32	7.82	7.53	7.47	7.54	7.41
POPULATION(5).....................	222.138	224.175	226.219	228.160	230.305	232.344	234.480	236.597	238.760	240.846	242.977
REAL PERS DISP INCOME PER CAPITA(6)	7487.0	7603.9	7617.8	7654.4	7943.8	8179.4	8368.3	8488.8	8552.7	8675.2	8811.2
RESIDENTIAL HOUSING STARTS(5)......	1.292	1.084	1.060	1.457	1.668	1.869	1.876	1.889	1.866	1.806	1.753
AAA BOND RATE(3)..................	11.94	14.17	13.79	11.12	10.34	10.26	10.35	10.37	10.34	10.12	9.83
MORTGAGE RATE(3)..................	12.66	14.70	15.14	8.34	8.85	9.25	9.67	9.05	9.03	9.17	8.91
FEDERAL RESERVE PRODUCTION INDEX(4)	147.0	151.0	138.6	140.19	153.23	164.14	170.88	177.14	182.54	188.78	196.95

(1) BILLIONS OF 1979 DOLLARS.
(2) INDEX EQUAL TO 1.0 IN 1979.
(3) PERCENTAGE.
(4) INDEX EQUAL TO 100 IN 1967.
(5) MILLIONS OF UNITS.
(6) 1979 DOLLARS.

NOTE: ENTRIES FOR 1980, 1981 AND 1982 ARE HISTORICAL DATA.

SOURCES: ON PAGE 222, SEE 9, PAGE 164, TABLE B-2; 9, PAGE 166, TABLE B-3; 9, PAGE 191, TABLE B-24; 9, PAGE 201, TABLE B-33; 9, PAGE 216, TABLE B-47; 9, PAGE 240, TABLE B-67; AND 9, PAGE 210, TABLE B-42.

TABLE B.4.1. RESIDENTIAL SECTOR FUEL CONSUMPTION BY END-USE SERVICE
CASE B: LOW WORLD OIL PRICE
(TRILLIONS OF BTU PER YEAR)

	1980	1985	1986	1987	1988	1989	1990
SPACE HEATING							
ELECTRICITY(1).....	201.	245.	260.	276.	291.	307.	322.
NATURAL GAS........	3225.	3003.	2951.	2902.	2856.	2813.	2773.
FUEL OIL...........	1172.	1131.	1169.	1197.	1213.	1218.	1217.
LIQUID GAS.........	390.	425.	438.	449.	455.	457.	457.
COAL...............	65.	76.	74.	73.	71.	69.	68.
MARKET TOTAL.......	5054.	4879.	4893.	4896.	4886.	4864.	4837.
WOOD...............	818.	1124.	1145.	1162.	1175.	1185.	1193.
WATER HEATING							
ELECTRICITY........	286.	319.	330.	341.	352.	363.	374.
NATURAL GAS........	1055.	1031.	1034.	1038.	1044.	1049.	1056.
FUEL OIL...........	244.	239.	240.	241.	241.	241.	241.
LIQUID GAS.........	149.	167.	172.	176.	178.	178.	178.
MARKET TOTAL.......	1734.	1755.	1776.	1796.	1815.	1832.	1848.
AIR CONDITIONING							
ELECTRICITY........	351.	382.	392.	402.	412.	422.	432.
NATURAL GAS........	12.	13.	13.	13.	13.	13.	14.
MARKET TOTAL.......	363.	394.	404.	415.	425.	436.	446.
OTHER END-USES(2)							
ELECTRICITY........	1610.	1705.	1749.	1791.	1833.	1874.	1914.
NATURAL GAS........	574.	548.	548.	547.	548.	548.	549.
MARKET TOTAL.......	2185.	2253.	2296.	2339.	2380.	2422.	2463.
FOR ALL END USES							
ELECTRICITY........	2448.	2649.	2731.	2810.	2888.	2966.	3042.
NATURAL GAS........	4866.	4595.	4545.	4501.	4460.	4424.	4391.
FUEL OIL...........	1417.	1369.	1409.	1438.	1455.	1459.	1458.
LIQUID GAS.........	539.	592.	611.	625.	632.	635.	635.
COAL...............	65.	76.	74.	73.	71.	69.	68.
MARKET TOTAL.......	9335.	9281.	9370.	9446.	9506.	9553.	9594.
WOOD...............	818.	1124.	1145.	1162.	1175.	1185.	1193.

(1) ELECTRIC SPACE HEATING INCLUDES BOTH ELECTRIC RESISTANCE AND HEAT PUMPS.
(2) SOME OF THE MAJOR USES ARE LIGHTING, COOKING, REFRIGERATION, WASHING, AND DRYING.
NOTE: ENTRIES FOR 1980 ARE A COMBINATION OF HISTORICAL AND ESTIMATED VALUES.
SOURCES: ON PAGE 222, SEE 1, PAGE 15; AND 19, PAGE 101, TABLE A4.

2. COMMERCIAL SECTOR ENERGY CONSUMPTION AND FLOORSPACE BY BUILDING CATEGORY
CASE B: LOW WORLD OIL PRICE
(CONSUMPTION IN QUADRILLION BTU PER YEAR, FLOORSPACE IN BILLIONS OF SQUARE FEET)

		1980	1985	1986	1987	1988	1989	1990
ALL CATEGORIES...	ALL FUELS.......	5.892	6.666	6.833	6.950	7.026	7.109	7.189
	NATURAL GAS.....	2.674	2.736	2.718	2.683	2.636	2.594	2.553
	ELECTRICITY.....	1.907	2.370	2.475	2.563	2.639	2.726	2.821
	FUEL OIL(1).....	1.122	1.387	1.471	1.540	1.591	1.632	1.664
	OTHER FUELS(2)..	0.190	0.173	0.170	0.165	0.161	0.156	0.152
	FLOORSPACE......	44.75	51.36	52.90	54.20	55.33	56.66	58.11
WAREHOUSE........	ALL FUELS.......	0.826	0.945	0.972	0.994	1.010	1.028	1.045
	NATURAL GAS.....	0.376	0.379	0.376	0.370	0.363	0.357	0.350
	ELECTRICITY.....	0.254	0.323	0.336	0.348	0.360	0.373	0.386
	FUEL OIL(1).....	0.167	0.216	0.235	0.250	0.262	0.274	0.286
	OTHER FUELS(2)..	0.028	0.026	0.026	0.025	0.025	0.024	0.023
	FLOORSPACE......	6.29	7.30	7.52	7.72	7.91	8.11	8.33
INSTITUTION(3)...	ALL FUELS.......	0.675	0.732	0.751	0.763	0.768	0.772	0.775
	NATURAL GAS.....	0.392	0.363	0.356	0.346	0.334	0.323	0.312
	ELECTRICITY.....	0.108	0.135	0.141	0.145	0.150	0.155	0.161
	FUEL OIL(1).....	0.155	0.217	0.238	0.256	0.269	0.279	0.287
	OTHER FUELS(2)..	0.019	0.017	0.017	0.016	0.016	0.015	0.014
	FLOORSPACE......	1.65	1.90	1.95	2.00	2.04	2.09	2.14
OFFICE...........	ALL FUELS.......	1.935	2.209	2.270	2.314	2.344	2.378	2.412
	NATURAL GAS.....	0.755	0.770	0.764	0.754	0.741	0.729	0.717
	ELECTRICITY.....	0.726	0.903	0.945	0.980	1.008	1.041	1.078
	FUEL OIL(1).....	0.393	0.479	0.505	0.527	0.543	0.556	0.567
	OTHER FUELS(2)..	0.062	0.056	0.055	0.054	0.053	0.051	0.050
	FLOORSPACE......	15.74	18.15	18.72	19.19	19.58	20.06	20.59
HOTEL AND MOTEL..	ALL FUELS.......	0.299	0.345	0.352	0.357	0.358	0.362	0.365
	NATURAL GAS.....	0.142	0.150	0.149	0.147	0.144	0.141	0.138
	ELECTRICITY.....	0.114	0.147	0.153	0.159	0.163	0.168	0.174
	FUEL OIL(1).....	0.033	0.039	0.041	0.043	0.044	0.044	0.044
	OTHER FUELS(2)..	0.010	0.009	0.009	0.009	0.008	0.008	0.008
	FLOORSPACE......	2.12	2.43	2.51	2.57	2.62	2.68	2.75
RETAIL/WHOLESALE.	ALL FUELS.......	1.552	1.823	1.874	1.910	1.936	1.963	1.989
	NATURAL GAS.....	0.733	0.796	0.799	0.796	0.789	0.785	0.780
	ELECTRICITY.....	0.545	0.684	0.717	0.745	0.770	0.798	0.828
	FUEL OIL(1).....	0.223	0.294	0.310	0.322	0.331	0.336	0.338
	OTHER FUELS(2)..	0.051	0.048	0.047	0.046	0.045	0.044	0.043
	FLOORSPACE......	13.18	15.40	15.92	16.36	16.74	17.19	17.69
MISCELLANEOUS(4).	ALL FUELS.......	0.606	0.614	0.614	0.612	0.609	0.606	0.604
	NATURAL GAS.....	0.276	0.277	0.274	0.270	0.265	0.260	0.255
	ELECTRICITY.....	0.160	0.179	0.182	0.185	0.188	0.191	0.194
	FUEL OIL(1).....	0.151	0.142	0.142	0.142	0.142	0.142	0.141
	OTHER FUELS(2)..	0.019	0.016	0.016	0.015	0.014	0.014	0.013
	FLOORSPACE......	5.76	6.20	6.29	6.37	6.45	6.53	6.61

(1) FUEL OIL CONSISTS OF LOW SULFUR RESIDUAL OIL AND DISTILLATE OIL.
(2) OTHER FUELS CONSIST OF LIQUID PETROLEUM GASES AND COAL.
(3) INCLUDES MAINLY HEALTH FACILITIES AND PENAL INSTITUTIONS.
(4) INCLUDES MAINLY RELIGIOUS FACILITIES, ASSEMBLEY HALLS, PARKING GARAGES, AND RECREATIONAL FACILITIES.

NOTE: ENTRIES FOR 1980 ARE A COMBINATION OF HISTORICAL AND ESTIMATED VALUES.
SOURCES: ON PAGE 222, SEE 1, PAGE 16.

TABLE B.4.3. INDUSTRIAL SECTOR ENERGY CONSUMPTION
CASE B: LOW WORLD OIL PRICE
(TRILLIONS OF BTU PER YEAR)

	1980	1985	1986	1987	1988	1989	1990
COAL....................	1387.88	1790.67	1829.03	1872.56	1934.71	2007.03	2094.22
NATURAL GAS.............	6497.36	4891.28	4835.37	4919.70	5124.44	5234.63	5419.67
(RAW MATERIALS(1).....	650.77	499.35	493.75	493.63	497.08	499.87	501.00)
DISTILLATE..............	1568.69	2606.04	2856.97	2832.71	2738.54	2587.98	2532.81
HI-SULFUR RESIDUAL......	713.20	964.69	1058.36	1078.91	1076.28	1042.15	1053.45
LO-SULFUR RESIDUAL......	553.58	608.56	652.91	663.30	668.66	655.24	671.15
ELECTRICITY.............	2780.85	3061.42	3204.97	3325.59	3498.04	3616.91	3802.58
LIQUID PETROLEUM GAS....	307.88	410.79	399.60	353.46	300.84	245.30	204.92
PET-CHEM FEEDSTOCKS(2)..	2401.48	2379.71	2521.37	2634.99	2748.19	2838.68	2987.58
METALLURGICAL COAL......	1793.34	1303.94	1327.22	1339.68	1355.35	1360.15	1375.07
OTHER(3)................	2180.32	2331.71	2373.66	2392.45	2403.74	2409.82	2434.26
TOTAL ENERGY............	20184.57	20348.80	21059.45	21413.34	21848.77	21997.87	22575.68

(1) NATURAL GAS CONSUMED AS A FEEDSTOCK BY THE CHEMICAL INDUSTRY (ALREADY INCLUDED IN THE NATURAL GAS TOTAL).

(2) CONSISTS OF STILL GAS USED FOR FEEDSTOCK PUROPSES, NAPTHAS LESS THAN 400 DEGREES, OTHER FUELS GREATER THAN 400 DEGREES, AND LIQUID PETROLEUM GASES USED FOR GAS UTILITY FUEL AND FOR CHEMICAL FEEDSTOCKS.

(3) ASPHALT, PETROLEUM COKE, LUBRICANTS, INDUSTRIAL KEROSENE, WAXES AND MISCELLANEOUS PETROLEUM PRODUCTS.

NOTE: INDUSTRIAL SECTOR TOTAL DIFFER FROM THOSE SHOWN IN THE "MONTHLY ENERGY REVIEW" BY EXCLUDING ELECTRICITY LOSSES, GASOLINE, NATURAL GAS USED AS A LEASE AND PLANT FUEL, AND ALL REFINERY FUELS EXCEPT COAL AND ELECTRICITY, AND BY INCLUDING LUBRICANTS CONSUMED BY THE TRANSPORTATION SECTOR. IN 1980 ONLY, THE RESIDUAL AND DISTILLATE DETAIL HAS BEEN CONVERTED TO THE NEW BASIS FOR CONSISTENCY WITH THE PETROLEUM BALANCE TABLE AND WITH 1980 FUEL DETAIL USED IN THE "SHORT-TERM ENERGY OUTLOOK."

NOTE: ENTRIES FOR 1980 ARE HISTORICAL DATA.

SOURCES: ON PAGE 222, SEE 1, PAGE 17; 15, PAGE 11, TABLE 5; AND 15, PAGE 127, TABLE 55.

TABLE B.4.4. TRANSPORTATION SECTOR ENERGY CONSUMPTION BY MODE
CASE B: LOW WORLD OIL PRICE

	1980	1985	1986	1987	1988	1989	1990
FUEL CONSUMPTION, ALL MODES							
GASOLINE(1)	13.253	12.891	12.633	12.119	11.537	10.992	10.613
DISTILLATE(1)	2.782	2.932	3.026	3.109	3.179	3.256	3.359
JET FUEL(1)	2.179	2.368	2.453	2.522	2.569	2.616	2.665
RESIDUAL(1)	1.401	1.077	1.115	1.145	1.166	1.186	1.215
LIQUID GAS(1)	0.014	0.015	0.015	0.015	0.015	0.015	0.015
FUEL USE IN LIGHT DUTY VEHICLES							
SALES:LIGHT DUTY VEHICLES(3)	10.750	13.254	13.644	14.125	14.702	15.081	15.004
VEHICLE-MILES:TOTAL(2)	1383.	1636.	1680.	1707.	1725.	1749.	1780.
FLEET-MILES PER GALLON:TOTAL	14.17	16.16	16.88	17.82	18.85	19.96	20.93
PERCENT FLEET VMT DIESEL	0.010	0.019	0.023	0.027	0.033	0.041	0.048
VEHICLE-MILES:GAS(2)	1368.	1605.	1642.	1660.	1668.	1678.	1694.
FLEET-MILES PER GALLON:GAS	13.95	15.98	16.67	17.56	18.53	19.55	20.44
FUEL USE:GAS(4)	98.080	100.427	98.502	94.535	90.041	85.839	82.888
VEHICLE-MILES:DIESEL(2)	14.	31.	38.	47.	57.	71.	86.
FLEET-MILES PER GALLON:DIESEL	25.34	26.59	27.26	28.19	29.19	30.28	31.19
FUEL USE:DIESEL(4)	0.564	1.173	1.387	1.652	1.966	2.346	2.760
FUEL USE IN HEAVY TRUCKS							
SALES:HEAVY TRUCKS(3)	0.487	0.644	0.675	0.706	0.736	0.756	0.734
VEHICLE-MILES:TOTAL(2)	105.	127.	132.	136.	139.	142.	146.
FLEET-MILES PER GALLON:TOTAL	5.82	6.85	7.07	7.29	7.52	7.75	7.94
PERCENT FLEET VMT DIESEL	0.591	0.656	0.669	0.683	0.697	0.710	0.722
VEHICLE-MILES:GAS(2)	43.	44.	44.	43.	42.	41.	41.
FLEET-MILES PER GALLON:GAS	6.84	8.29	8.60	8.92	9.25	9.56	9.78
FUEL USE:GAS(4)	6.266	5.289	5.092	4.849	4.569	4.306	4.148
VEHICLE-MILES:DIESEL(2)	62.	83.	89.	93.	97.	101.	106.
FLEET-MILES PER GALLON:DIESEL	5.09	6.09	6.31	6.54	6.77	7.01	7.23
FUEL USE:DIESEL(4)	12.168	13.705	14.034	14.242	14.331	14.402	14.595
FUEL USE IN AIR							
REVENUE PASSENGER-MILES(3)	265.	352.	376.	395.	409.	422.	437.
AVERAGE FLIGHT SIZE	158.	167.	170.	173.	175.	177.	179.
LOAD FACTOR	0.62	0.64	0.65	0.65	0.66	0.66	0.66
FUEL BURNED PER SEAT-MILE(5)	0.023	0.022	0.021	0.021	0.021	0.020	0.020
TOTAL JET FUEL(4)	16.543	19.324	20.021	20.583	20.971	21.354	21.751
FUEL USE IN OTHER							
NON-HWY DSL(1)	4.438	4.704	4.789	4.871	4.936	5.003	5.082
RESIDUAL(1)	1.550	1.833	1.898	1.950	1.985	2.019	2.069

(1) QUADRILLION BTU PER YEAR.
(2) BILLIONS PER YEAR.
(3) MILLIONS PER YEAR.
(4) BILLIONS OF GALLONS PER YEAR.
(5) GALLONS PER YEAR.
NOTE: ENTRIES FOR 1980 ARE A COMBINATION OF HISTORICAL AND ESTIMATED VALUES.

TABLE B.5.1. ELECTRIC UTILITY FUEL PRICES AND CONSUMPTION
CASE B: LOW WORLD OIL PRICE
(1982 DOLLARS PER MILLION BTU; TRILLIONS OF BTU PER YEAR)

YEARS	COAL	NATURAL GAS	DISTILLATE	LO-S RESID	HI-S RESID	FOSSIL FUEL	NUCLEAR	HYDRO	ALL FUELS
FUEL PRICES									
1980	1.71	2.80	7.22	5.90	4.55	NA	NA	--	NA
1985	1.74	5.23	4.85	4.10	3.07	2.48	0.85	--	1.95
1986	1.75	5.80	4.86	4.15	3.13	2.56	0.85	--	1.99
1987	1.77	6.19	5.16	4.43	3.38	2.65	0.85	--	2.04
1988	1.79	6.34	5.55	4.79	3.71	2.76	0.85	--	2.11
1989	1.81	6.66	6.06	5.29	4.11	2.88	0.85	--	2.19
1990	1.86	6.83	6.39	5.61	4.44	3.00	0.85	--	2.28
FUEL CONSUMPTION									
1980	12122.	3807.	121.	1611.	922.	18583.	2672.	2988.	24243.
1985	14133.	1598.	496.	2646.	1201.	20073.	4118.	3133.	27325.
1986	14453.	1625.	568.	2694.	1215.	20555.	4678.	3149.	28383.
1987	14789.	1643.	575.	2725.	1231.	20883.	5253.	3153.	29289.
1988	15090.	1679.	652.	2741.	1243.	21403.	5782.	3169.	30354.
1989	15575.	1705.	702.	2751.	1236.	21969.	6114.	3194.	31278.
1990	16264.	1746.	835.	2785.	1255.	22884.	6331.	3227.	32442.

NA=NOT AVAILABLE.
--=NOT APPLICABLE.
NOTE: ENTRIES FOR 1980 ARE HISTORICAL DATA.
SOURCES: ON PAGE 222, SEE 1; 2, PP 160-170, TABLES B1, B2, B3, AND B4; 2, PP 253-255, TABLE C9; 2, PP 262-263, TABLE C13; 2, PP 270-271, TABLE C17; AND 2, PP 290-291, TABLE C27.

TABLE B.5.2. END-USE ELECTRICITY PRICES AND CONSUMPTION
CASE B: LOW WORLD OIL PRICE
(1982 MILLS PER KWH; BILLION KWH PER YEAR)

YEARS	RESIDENTIAL	COMMERCIAL	TRANSPORTATION	INDUSTRIAL	AVG./TOTAL
END-USE PRICES					
1980	57.25	58.72	NA	39.82	50.82
1985	56.85	57.43	55.23	46.92	53.26
1986	57.45	58.00	55.80	47.47	53.81
1987	58.41	58.97	56.79	48.39	54.75
1988	58.73	59.41	57.53	48.72	55.05
1989	59.41	60.21	58.21	49.37	55.75
1990	60.00	60.84	58.80	49.98	56.30
END-USE CONSUMPTION					
1980	717.50	558.91	0.00	815.06	2091.47
1985	776.46	694.72	3.05	897.30	2371.53
1986	800.29	725.40	3.05	939.38	2468.10
1987	823.51	751.11	3.05	974.73	2552.39
1988	846.48	773.36	3.05	1025.28	2648.17
1989	869.23	799.09	3.05	1068.12	2731.48
1990	891.62	826.70	3.05	1114.54	2835.90

NA=NOT AVAILABLE.
NOTE: ENTRIES FOR 1980 ARE HISTORICAL DATA.
SOURCES: ON PAGE 222, SEE 1, PP 15-18; AND 2, PP 229-40, TABLES C1, C2, C3, AND C4.

TABLE B.5.3. ELECTRIC UTILITY CAPACITY AND GENERATION
CASE B: LOW WORLD OIL PRICE
(CAPACITY IN GIGAWATTS; GENERATION IN BILLION KWH)

CAPACITY TYPE		1980	1985	1986	1987	1988	1989	1990
COAL STEAM	CAPACITY...	176.58	224.96	233.92	238.89	246.92	255.00	265.72
	GENERATION.	943.4	1147.5	1184.1	1211.5	1247.5	1290.2	1349.3
NATURAL GAS STEAM	CAPACITY...	40.99	40.99	40.99	40.99	40.99	40.99	40.99
	GENERATION.	158.2	74.7	76.8	78.2	77.8	75.6	73.9
OIL STEAM	CAPACITY...	32.27	35.07	35.07	35.07	35.12	35.12	35.12
	GENERATION.	113.0	126.6	128.1	128.3	128.7	129.0	131.0
NG/COAL STEAM	CAPACITY...	32.31	32.46	32.46	32.46	32.46	32.46	32.46
	GENERATION.	123.5	103.7	98.3	97.2	98.9	103.7	107.8
OIL/COAL STEAM	CAPACITY...	40.18	40.18	40.18	40.18	40.18	40.18	40.18
	GENERATION.	149.5	150.7	153.1	153.1	154.0	155.0	160.4
NG/OIL STEAM	CAPACITY...	69.81	69.81	69.81	69.81	69.81	69.81	69.81
	GENERATION.	233.0	244.5	249.0	253.4	252.0	251.8	260.2
NG COMBINED CYCLE	CAPACITY...	4.45	4.45	4.45	4.45	4.45	4.45	4.45
	GENERATION.	12.7	17.7	19.8	19.3	24.5	24.2	20.0
OIL COMBINED CYCLE	CAPACITY...	3.34	3.49	3.49	3.49	3.49	3.49	3.49
	GENERATION.	2.3	8.8	9.3	9.4	11.2	11.5	12.3
NATURAL GAS TURBINE	CAPACITY...	4.64	5.06	5.06	5.06	5.06	5.06	5.06
	GENERATION.	5.3	0.8	1.5	1.3	2.7	4.0	6.0
OIL TURBINE	CAPACITY...	46.51	48.09	48.20	48.28	48.34	48.51	48.58
	GENERATION.	5.6	14.4	18.0	18.3	20.5	21.5	27.6
NG/OIL TURBINE	CAPACITY...	52.62	52.68	52.68	52.68	52.68	52.68	52.68
	GENERATION.	8.1	8.5	7.3	7.5	9.3	13.6	16.1
NUCLEAR	CAPACITY...	50.18	77.94	88.30	99.06	106.37	112.76	113.93
	GENERATION.	251.0	387.1	439.7	493.8	543.5	574.8	595.1
PUMP STORAGE HYDRO(1)	CAPACITY...	88.20	14.25	15.82	18.66	19.50	20.28	20.54
	GENERATION.	282.0	13.4	17.9	23.9	28.3	32.7	38.1
PONDAGE HYDRO(1)	CAPACITY...	--	72.85	72.44	72.52	72.65	72.85	72.92
	GENERATION.	--	302.7	304.2	304.6	306.1	308.6	311.8
DOMESTIC TOTAL	CAPACITY...	642.08	721.48	742.87	761.60	778.02	793.64	805.93
	GENERATION.	2287.6	2601.1	2707.1	2799.8	2905.0	2996.2	3109.6
CANADIAN IMPORTS	GENERATION.	26.72	94.29	96.73	98.90	101.32	104.01	107.10

(1) IN 1980, PONDAGE HYDROPOWER IS INCLUDED IN PUMP STORAGE HYDROPOWER.
--=NOT APPLICABLE.
NOTE: "CAPACITY" INDICATES THE POTENTIAL AMOUNT OF ELECTRICAL POWER THAT COULD BE GENERATED IF POWERPLANTS OPERATED NONSTOP.
NOTE: "GENERATION" INDICATES THE AMOUNT OF ELECTRICITY PRODUCED FROM EACH CAPACITY TYPE.
NOTE: ENTRIES FOR 1989 ARE A COMBINATION OF HISTORICAL AND ESTIMATED VALUES.
SOURCES: ON PAGE 222, SEE 10, PP 273-287, TABLE 9; AND 11, PAGE 1, TABLE 1.

TABLE B.5.4. SCHEDULED ELECTRIC UTILITY CAPACITY ADDITIONS
CASE B: LOW WORLD OIL PRICE
(CAPACITY IN MEGAWATTS)

NEW CAPACITY TYPE	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	TOTAL
COAL STEAM.........	13633.	9499.	9821.	7023.	8088.	10524.	4918.	6198.	7753.	9537.	9269.	96261.
OIL STEAM..........	987.	1895.	0.	0.	0.	10.	0.	0.	50.	0.	0.	2942.
NG/COAL STEAM.....	570.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	570.
OIL CC............	0.	0.	90.	60.	0.	0.	0.	0.	0.	0.	0.	150.
NG TURBINE.........	76.	375.	8.	0.	0.	0.	0.	0.	0.	0.	0.	459.
OIL TURBINE.......	978.	238.	230.	320.	82.	154.	73.	97.	54.	140.	94.	2460.
NG/OIL TURBINE....	0.	60.	0.	0.	0.	0.	0.	0.	0.	0.	0.	60.
NUCLEAR...........	1819.	3912.	3296.	5250.	9269.	9183.	14455.	4910.	10063.	2355.	0.	64512.
PUMP STORAGE......	256.	0.	997.	531.	0.	1050.	2050.	2325.	0.	955.	150.	8314.
PONDAGE HYDRO.....	1373.	259.	772.	923.	679.	482.	187.	103.	232.	74.	0.	5083.
TOTAL NEW CAPACITY	19692.	16237.	15214.	14107.	18118.	21403.	21683.	13633.	18152.	13061.	9513.	180806.

SOURCES: ON PAGE 222, SEE 10, PP 27-259, TABLE 7; AND 10, PP 273-287, TABLE 9.

TABLE B.5.5. SUMMARY OF COMPONENTS OF ELECTRICITY PRICE
CASE B: LOW WORLD OIL PRICE
(1982 MILLS PER KWH)

	1980	1985	1986	1987	1988	1989	1990
PRIVATE UTILITIES							
CAPITAL COMPONENT...	10.21	10.11	10.36	10.18	10.34	10.87	9.72
FUEL COMPONENT......	26.14	25.28	25.61	26.13	26.69	27.55	28.48
O&M COMPONENT(1)....	8.33	8.68	8.68	8.67	8.63	8.61	8.50
OTHERS(2)...........	12.22	11.35	11.41	12.07	11.72	11.90	11.88
TOTAL PRICE.........	56.90	55.42	56.06	57.06	57.38	58.12	58.59
PUBLIC & PRIVATE UTILITIES							
CAPITAL COMPONENT...	10.51	10.59	10.70	10.50	10.50	10.18	9.90
FUEL COMPONENT......	25.32	24.30	24.65	25.17	25.79	26.69	27.68
O&M COMPONENT(1)....	8.06	8.41	8.41	8.41	8.36	8.34	8.25
OTHERS(2)...........	10.67	9.96	10.05	10.67	10.40	10.53	10.48
TOTAL PRICE.........	54.55	53.26	53.81	54.75	55.05	55.75	56.30

(1) OPERATION AND MAINTENANCE.
(2) INCLUDES DEPRECIATION AND TAXES.
NOTE: ENTRIES FOR 1980 ARE A COMBINATION OF HISTORICAL AND ESTIMATED VALUES.

TABLE B.6.1. ANNUAL SUPPLY AND DISPOSITION OF PETROLEUM
CASE B: LOW WORLD OIL PRICE
(MILLIONS OF BARRELS PER DAY)

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
SUPPLY											
PRODUCTION											
CRUDE OIL	8.60	8.57	8.67	8.64	8.69	8.63	8.58	8.47	8.34	8.17	7.71
NORTH SLOPE	1.52	1.53	1.61	1.63	1.70	1.71	1.78	1.78	1.78	1.82	1.73
SUBARCTIC(1)	7.08	7.05	7.06	7.00	6.98	6.88	6.71	6.55	6.37	6.10	5.70
NATURAL GAS LIQUIDS	1.57	1.61	1.55	1.54	1.35	1.19	1.13	1.11	1.14	1.17	1.22
OTHER DOMESTIC(2)	0.04	0.05	0.05	0.05	0.02	0.04	0.09	0.14	0.19	0.24	0.29
PROCESSING GAIN	0.60	0.51	0.53	0.49	0.55	0.60	0.61	0.61	0.60	0.60	0.60
TOTAL PRODUCTION	10.81	10.74	10.81	10.72	10.58	10.41	10.32	10.19	10.08	9.94	9.53
IMPORTS(3)											
CRUDE OIL	5.26	4.40	3.46	3.75	5.69	7.39	7.84	7.90	7.83	7.72	8.13
REFINED PRODUCTS(4)	1.65	1.60	1.58	1.76	2.06	2.15	2.20	2.21	2.21	2.20	2.21
TOTAL IMPORTS	6.91	6.00	5.04	5.51	7.75	9.54	10.04	10.12	10.04	9.91	10.34
EXPORTS											
CRUDE OIL	0.29	0.23	0.24	0.23	0.25	0.25	0.25	0.25	0.25	0.25	0.25
REFINED PRODUCTS(4)	0.26	0.37	0.58	0.55	0.62	0.62	0.62	0.62	0.62	0.62	0.62
TOTAL EXPORTS	0.54	0.59	0.82	0.78	0.87	0.87	0.87	0.87	0.87	0.87	0.87
NET IMPORTS	6.37	5.40	4.23	4.72	6.88	8.67	9.17	9.25	9.17	9.04	9.47
PRIMARY STOCK CHANGES(5)											
NET WITHDRAWALS	-0.09	0.18	0.32	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SPR FILL RATE ADDITIONS(6)	-0.05	-0.34	-0.17	-0.21	-0.15	-0.15	-0.15	-0.15	-0.15	-0.15	-0.15
TOTAL PRIMARY SUPPLY	17.04	15.98	15.18	15.37	17.31	18.93	19.34	19.29	19.10	18.83	18.85
PRODUCT SUPPLIED											
MOTOR GASOLINE	6.86	6.59	6.54	6.36	6.68	6.73	6.59	6.33	6.02	5.74	5.54
DISTILLATE FUEL OIL	2.97	2.83	2.67	2.75	3.30	3.87	4.10	4.17	4.21	4.21	4.31
RESIDUAL FUEL OIL	2.56	2.09	1.69	1.73	2.67	3.40	3.55	3.61	3.63	3.60	3.65
OTHER PRODUCTS(7)	5.11	4.83	4.66	4.83	4.97	5.28	5.45	5.53	5.58	5.61	5.70
TOTAL RECLASSIFIED(8)	-0.44	-0.27	-0.31	-0.30	-0.31	-0.34	-0.34	-0.34	-0.34	-0.33	-0.33
TOTAL PRODUCT SUPPLIED	17.06	16.06	15.25	15.37	17.32	18.94	19.35	19.29	19.11	18.83	18.86
DISCREPANCY	-0.02	-0.08	-0.07	0.00	-0.01	-0.01	-0.01	-0.00	-0.01	-0.00	-0.01
NET DISPOSITION	17.04	15.98	15.18	15.37	17.31	18.93	19.34	19.29	19.10	18.83	18.85

(1) INCLUDES LOWER-48 STATES AND SOUTHERN ALASKA.
(2) OTHER DOMESTIC REPRESENTS OTHER HYDROCARBON INPUT.
(3) INCLUDES IMPORTS FOR THE STRATEGIC PETROLEUM RESERVE.
(4) CONSISTS OF NATURAL GAS PLANT LIQUIDS, UNFINISHED OILS, AND REFINED PRODUCT IMPORTS.
(5) EXCLUDES CRUDE OIL FOR THE STRATEGIC PETROLEUM RESERVE.
(6) ADDITIONS TO THE STRATEGIC PETROLEUM RESERVE (SHOWN AS NEGATIVE ENTRIES).
(7) COMPOSED OF JET FUEL, LIQUEFIED GASES, AND OTHER PRODUCTS.
(8) PETROLEUM PRODUCTS REPROCESSED INTO OTHER PRODUCT CATEGORIES.

NOTE: IN 1980, GASOLINE SUPPLIED HAS BEEN ADJUSTED TO CORRECT UNDERESTIMATION OF PRODUCT SUPPLIED. DISTILLATE AND RESIDUAL FUEL OIL HAVE BEEN RESTATED INTO THE NEW BASIS FOR COMPARABILITY PURPOSES.

NOTE: ENTRIES FOR 1980 ARE A COMBINATION OF HISTORICAL AND ESTIMATED VALUES.

SOURCES: ON PAGE 222, SEE 4, PAGE 6, TABLE 1; AND 20, PAGE 18, TABLE 7.

TABLE B.7.1. NATURAL GAS SUPPLY/DEMAND BALANCE
CASE B: LOW WORLD OIL PRICE
(TRILLION BTU PER YEAR; 1982 DOLLARS PER MILLION BTU)

	1980	1985	1986	1987	1988	1989	1990
LOWER-48 ONSHORE SUPPLY	14435.	11003.	10164.	9780.	10118.	10749.	11665.
LOWER-48 OFFSHORE SUPPLY	5477.	3911.	4016.	4189.	4173.	4015.	3680.
TOTAL DOMESTIC SUPPLY	19912.	14914.	14180.	13969.	14291.	14764.	13345.
CATEGORY 102 (NEW GAS)	3439.	5950.	6183.	6686.	7438.	8412.	9161.
CATEGORY 104 (OLD INTERSTATE GAS)	8910.	5730.	4980.	4360.	3850.	3440.	3090.
CATEGORY 105 (OLD INTRASTATE GAS)	6899.	3050.	2750.	2550.	2370.	2110.	2000.
CATEGORY 107 (DEEP GAS)	664.	185.	268.	373.	634.	802.	1094.
SUPPLEMENTAL GAS(1)	159.	90.	630.	850.	731.	380.	32.
IMPORTS	957.	1230.	1230.	1230.	1230.	1230.	1230.
TOTAL SUPPLY	21028.	16234.	16041.	16048.	16253.	16375.	16607.
LEASE AND PLANT FUEL(2)	1045.	1119.	1064.	1048.	1072.	1107.	1151.
TRANSPORTATION LOSS(3)	647.	1045.	1038.	1037.	1044.	1050.	1058.
CONSUMPTION BY SECTOR							
RESIDENTIAL	4866.	4596.	4545.	4501.	4460.	4424.	4391.
COMMERCIAL(4)	2674.	2736.	2718.	2683.	2636.	2594.	2553.
REFINERY	846.	251.	216.	216.	236.	260.	284.
ELECTRIC UTILITY	3807.	1598.	1625.	1643.	1679.	1705.	1746.
INDUSTRIAL(5)	6497.	4891.	4835.	4920.	5124.	5235.	5425.
TOTAL END-USE CONSUMPTION	18690.	14070.	13939.	13963.	14135.	14218.	14398.
DISCREPANCY(6)	-646.	0.	0.	0.	0.	0.	0.
WELLHEAD PRICES							
AVERAGE PRICE	1.79	3.29	3.68	4.10	4.44	4.72	4.93
CATEGORY 102 (NEW GAS)	2.69	4.11	4.51	4.92	5.20	5.41	5.54
CATEGORY 104 (OLD INTERSTATE GAS)	1.32	2.08	2.24	2.35	2.44	2.51	2.55
CATEGORY 105 (OLD INTRASTATE GAS)	1.67	3.95	4.33	4.82	5.10	5.32	5.46
CATEGORY 107 (DEEP GAS)	4.78	4.11	4.51	4.92	5.20	5.41	5.54
DELIVERED PRICE BY SECTOR							
RESIDENTIAL	4.16	6.39	6.89	7.28	7.64	7.95	8.33
COMMERCIAL(4)	3.84	6.16	6.69	7.12	7.50	7.87	8.27
REFINERY	3.08	4.45	4.89	5.26	5.52	5.81	6.03
ELECTRIC UTILITY	2.80	5.23	5.80	6.19	6.36	6.66	6.83
INDUSTRIAL(5)	2.90	5.33	5.85	6.22	6.45	6.75	7.00

(1) INCLUDES INCREASED GAS OR OIL IMPORTS.
(2) REPRESENTS GAS USED AS A FUEL IN FIELD GATHERING AND PLANT PROCESSING MACHINERY.
(3) INDICATES GAS USED TO FUEL COMPRESSORS IN THE PIPELINE MACHINERY.
(4) COMMERCIAL IS AN AGGREGATE OF COMMERCIAL AND OTHER CATEGORIES.
(5) EXCLUDES LEASE AND PLANT FUEL CONSUMPTION.
(6) REPRESENTS IMBALANCES RESULTING FROM THE MERGER OF DATA REPORTING SYSTEMS WHICH VARY IN SCOPE, FORMAT, DEFINITIONS AND TYPE OF RESPONDANTS.

NOTE: ENTRIES FOR 1980 ARE A COMBINATION OF HISTORICAL AND ESTIMATED VALUES.

SOURCES: ON PAGE 222, SEE 1, PP 15-19; 12, PAGE 7, TABLE 1; 13, PAGE 133, TABLE A7.

TABLE B.8.1. COAL SUPPLY AND DISPOSITION
CASE B: LOW WORLD OIL PRICE
(MILLIONS OF SHORT TONS PER YEAR)

	1980	1985	1986	1987	1988	1989	1990
DOMESTIC SUPPLY							
EASTERN.............	579.	603.	618.	629.	645.	664.	688.
WESTERN.............	251.	309.	319.	330.	345.	361.	385.
NET IMPORTS(1)......	-91.	-108.	-114.	-120.	-127.	-135.	-143.
STOCK WITHDRAWALS...	-36.	0.	0.	0.	0.	0.	0.
TOTAL SUPPLY..........	703.	804.	823.	839.	862.	890.	930.
CONSUMPTION							
RESIDENTIAL/COMM....	7.	7.	7.	7.	7.	6.	6.
INDUSTRIAL..........	60.	76.	77.	79.	81.	84.	88.
METALLURGICAL.......	67.	49.	50.	50.	51.	51.	52.
ELECTRIC UTILITY....	569.	666.	683.	697.	718.	743.	779.
SYNTHETIC USE.......	0.	5.	5.	5.	5.	5.	5.
TOTAL CONSUMPTION.....	703.	804.	823.	839.	862.	890.	930.
TOTAL DISPOSITION.....	703.	804.	823.	839.	862.	890.	930.

(1) EXPORTS TO EUROPE AND JAPAN.

NOTE: EASTERN INCLUDES PENSYLVANIA, OHIO, MARYLAND, WEST VIRGINIA, VIRGINIA, KENTUCKY, TENNESSEE, ALABAMA, ILLINOIS, AND INDIANA. WESTERN INCLUDES IOWA, MISSOURI, KANSAS, ARKANSAS, OKLAHOMA, TEXAS, NORTH DAKOTA, SOUTH DAKOTA, MONTANA, WYOMING, COLORADO, UTAH, ARIZONA, NEW MEXICO, WASHINGTON, AND ALASKA.

NOTE: ENTRIES FOR 1980 ARE HISTORICAL DATA, AND STOCK WITHDRAWALS INCLUDES DISCREPANCY.

Case C
High World Oil Price Forecast

In the high price case (Case C), total energy demand would be about 3 percent lower in 1985. Total oil consumption would decline by 2.9 quadrillion Btu, but oil imports would decrease by 3.4 quadrillion Btu, while domestic oil production would increase by .6 quadrillion Btu. Domestic supplies of natural gas would also subsitute for oil imports as they would increase by about 2.6 percent.

This shift away from oil imports would continue to increase throughout the forecast horizon. By 1990, oil imports are projected to be about 30 percent lower in the high price case than in the midprice case. The high price path would also increase the projected production of both domestic oil and natural gas by about 6.4 percent.

THE FOLLOWING SECTION OF TABLES ARE FOR THE:

CASE C: HIGH WORLD OIL PRICE

THIS SECTION CONTAINS THE FOLLOWING TABLES:

EXECUTIVE SUMMARY TABLES
    TABLE C.1.1. YEARLY SUPPLY AND DISPOSITION OF TOTAL ENERGY
    TABLE C.1.2. SUPPLY/DEMAND BALANCE
    TABLE C.1.3. CONSUMPTION SUMMARY
    TABLE C.1.4. PRICE SUMMARY

MACROECONOMIC TABLE
    TABLE C.3.1. NATIONAL MACROECONOMIC INDICATORS

END-USE CONSUMPTION TABLES
    TABLE C.4.1. RESIDENTIAL SECTOR FUEL CONSUMPTION BY END-USE SERVICE
    TABLE C.4.2. COMMERCIAL SECTOR ENERGY CONSUMPTION AND FLOORSPACE BY BUILDING CATEGORY
    TABLE C.4.3. INDUSTRIAL SECTOR ENERGY CONSUMPTION
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ELECTRIC UTILITY TABLES
    TABLE C.5.1. ELECTRIC UTILITY FUEL PRICES AND CONSUMPTION
    TABLE C.5.2. END-USE ELECTRICITY PRICES AND CONSUMPTION
    TABLE C.5.3. ELECTRIC UTILITY CAPACITY AND GENERATION
    TABLE C.5.4. SCHEDULED ELECTRIC UTILITY CAPACITY ADDITIONS
    TABLE C.5.5. SUMMARY OF COMPONENTS OF ELECTRICITY PRICE

PETROLEUM SUPPLY TABLE
    TABLE C.6.1. ANNUAL SUPPLY AND DISPOSITION OF PETROLEUM

NATURAL GAS SUPPLY TABLE
    TABLE C.7.1. NATURAL GAS SUPPLY/DEMAND BALANCE

COAL SUPPLY TABLE
    TABLE C.8.1. COAL SUPPLY AND DISPOSITION

TABLE C.1.1. YEARLY SUPPLY AND DISPOSITION OF TOTAL ENERGY
CASE C: HIGH WORLD OIL PRICE
(QUADRILLION BTU PER YEAR)

	1975	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
SUPPLY												
PRODUCTION												
PETROLEUM..........	20.1	20.5	20.4	20.6	20.5	20.9	21.0	21.3	21.5	21.6	21.4	20.5
NATURAL GAS........	19.6	20.1	19.9	18.2	17.5	17.2	15.6	15.4	15.7	16.2	16.8	17.5
COAL...............	15.2	19.2	19.1	19.1	19.4	19.4	20.3	20.9	21.5	22.2	23.0	24.0
NUCLEAR............	1.9	2.7	2.9	3.0	3.2	3.7	4.1	4.7	5.3	5.8	6.1	6.3
HYDRO/GEO/OTHER....	3.2	3.0	2.9	3.3	3.2	3.1	3.1	3.1	3.2	3.2	3.2	3.2
SUBTOTAL..........	60.1	65.5	65.2	64.2	63.7	64.3	64.2	65.5	67.0	68.9	70.5	71.5
NET IMPORTS												
CRUDE OIL..........	8.7	10.6	8.8	6.8	7.5	8.4	9.7	8.8	8.0	7.5	7.0	7.5
OTHER PETROLEUM....	3.8	2.9	2.6	2.1	2.5	2.9	3.0	3.0	3.0	3.0	3.0	3.0
NG (CONTRACTED)(1).	0.9	1.0	.9	.9	1.1	1.2	1.2	1.2	1.2	1.2	1.2	1.2
OTHER GAS(2).......	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.0
COAL AND COKE......	-1.7	-2.4	-2.9	-2.8	-2.6	-2.7	-2.9	-3.0	-3.2	-3.4	-3.6	-3.8
ELECTRICITY........	0.1	.2	.2	.2	.2	0.3	0.3	0.3	0.3	0.3	0.4	0.4
SUBTOTAL..........	11.7	12.3	9.6	7.3	8.6	10.8	11.3	10.3	9.4	8.7	8.0	8.3
SPR ADDITIONS(3)....	0.0	-.1	-.7	-.4	-.4	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3
STOCK WITHDRAWALS...	-1.1	-1.8	0.0	-.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL SUPPLY.........	70.7	75.9	74.1	70.9	71.9	74.8	75.2	75.5	76.1	77.3	78.2	79.5
CONSUMPTION												
NON-ELEC UTILITY FUEL												
PETROLEUM..........	29.5	31.5	29.9	28.6	29.2	29.6	29.7	29.3	28.9	28.5	28.2	28.0
NATURAL GAS(4).....	16.7	16.6	16.1	15.0	14.9	14.6	13.7	13.5	13.5	13.8	13.9	14.2
COAL...............	4.0	3.4	3.4	3.0	2.9	3.2	3.3	3.4	3.5	3.6	3.7	3.9
SUBTOTAL..........	50.2	51.4	49.4	46.4	47.0	47.4	46.7	46.1	45.8	45.9	45.9	46.1
ELECTRIC UTILITY FUEL												
PETROLEUM..........	3.2	2.7	2.2	1.8	1.5	2.3	3.6	3.6	3.4	3.4	2.9	2.8
NATURAL GAS........	3.2	3.8	3.8	3.3	3.4	3.3	2.1	2.1	2.4	2.5	3.0	3.4
COAL...............	8.8	12.1	12.7	12.7	13.2	13.6	14.2	14.5	14.8	15.2	15.7	16.3
NUCLEAR............	1.9	2.7	2.9	3.0	3.2	3.7	4.1	4.7	5.3	5.8	6.1	6.3
HYDRO/GEO/OTHER(5).	3.4	3.2	3.1	3.5	3.4	3.4	3.5	3.5	3.5	3.5	3.5	3.6
SUBTOTAL..........	20.5	24.5	24.7	24.3	24.7	26.0	27.1	28.1	29.0	30.0	30.9	32.1
TOTAL CONSUMPTION....	70.7	75.9	74.1	70.7	71.7	73.3	73.9	74.2	74.8	76.0	76.9	78.2
ADJUSTMENTS												
REFINERY LOSSES(6).	0.0	0.0	0.0	0.0	-0.1	-0.1	0.1	0.1	0.1	0.2	0.1	0.1
DISCREPANCY(7).....	0.0	0.0	0.0	0.2	0.3	1.6	1.2	1.2	1.2	1.1	1.2	1.2
TOTAL DISPOSITION....	70.7	75.9	74.1	70.9	71.9	74.8	75.2	75.5	76.1	77.3	78.2	79.5

NOTE: THE "ANNUAL ENERGY REVIEW" FOR 1982 WILL CONTAIN LATER REVISIONS TO HISTORICAL DATA FOR 1975, 1980 AND 1982.
NOTE: TOTALS MAY NOT EQUAL SUM OF COMPONENTS DUE TO INDEPENDENT ROUNDING. FOR TABLE FOOTNOTES AND SOURCES SEE PAGE 219.

TABLE C.1.2. SUPPLY/DEMAND BALANCE
CASE C: HIGH WORLD OIL PRICE
(QUADRILLION BTU PER YEAR)

	1975	1980	1985	1986	1987	1988	1989	1990
DOMESTIC SUPPLY								
COAL..................	15.2	19.2	20.3	20.9	21.5	22.2	23.0	24.0
NATURAL GAS...........	19.6	19.9	15.6	15.4	15.7	16.2	16.8	17.5
PETROLEUM.............	20.1	20.5	21.0	21.3	21.5	21.6	21.4	20.5
NUCLEAR...............	1.9	2.7	4.1	4.7	5.3	5.8	6.1	6.3
OTHER(1)..............	3.2	3.0	3.1	3.1	3.2	3.2	3.2	3.2
TOTAL DOMESTIC SUPPLY.................	60.0	65.3	64.2	65.5	67.0	68.9	70.5	71.5
NATURAL GAS IMPORTS...	0.9	1.0	1.2	1.2	1.2	1.2	1.2	1.2
SUPPLEMENTAL GAS(2)...	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0
PETROLEUM IMPORTS.....	12.5	13.5	12.6	11.8	11.0	10.4	10.0	10.5
TOTAL SUPPLY(3).........	73.4	80.0	78.1	78.5	79.3	80.6	81.7	83.2
DISPOSITION								
RESIDENTIAL...........	9.6	9.3	9.1	9.1	9.0	9.0	9.0	9.0
COMMERCIAL............	5.5	5.9	6.5	6.6	6.6	6.6	6.6	6.6
INDUSTRIAL(4).........	21.3	23.0	21.0	21.1	21.4	22.1	22.5	23.2
TRANSPORTATION........	17.7	19.7	17.6	17.1	16.8	16.5	16.3	16.1
TOTAL END-USE CONSUMPTION.............	54.1	57.9	54.2	53.8	53.8	54.2	54.4	54.9
DISCREPANCY.............	0.2	-0.1	-0.1	[illegible]	-0.2	-0.3	-0.3	-0.4
ADJUSTMENTS.............	19.1	22.2	24.0	24.9	25.7	26.7	27.6	28.7
UTILITY GENERATION....	13.7	16.5	18.3	18.9	19.5	20.2	20.8	21.5
UTILITY TRANSMISSION..	0.6	0.7	0.9	0.9	0.9	1.0	1.0	1.0
REFINERY(5)...........	0.0	0.0	0.1	0.1	0.1	0.2	0.1	0.1
GAS PIPELINE(6).......	0.6	0.6	1.1	1.1	1.1	1.1	1.1	1.2
LEASE/PLANT FUEL(7)...	1.4	1.0	1.2	1.2	1.2	1.2	1.3	1.3
COAL EXPORTS..........	1.7	2.4	2.9	3.0	3.2	3.4	3.6	3.8
SPR ADDITIONS.........	0.0	0.1	0.3	0.3	0.3	0.3	0.3	0.3
STOCK WITHDRAWALS.....	1.1	1.8	0.0	0.0	0.0	0.0	0.0	0.0
RECLASSIFIED..........	0.0	-0.9	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6
ADJUSTED CONSUMPTION....	73.4	80.0	78.1	78.5	79.3	80.6	81.7	83.2
ELECTRIC UTILITY FUEL								
COAL..................	8.8	12.1	14.2	14.5	14.8	15.2	15.7	16.3
PETROLEUM.............	3.2	2.7	3.6	3.6	3.4	3.4	2.9	2.8
NATURAL GAS...........	3.2	3.8	2.1	2.1	2.4	2.5	3.0	3.4
TOTAL FOSSIL............	15.2	18.6	19.9	20.3	20.6	21.1	21.6	22.5
NUCLEAR...............	1.9	2.7	4.1	4.7	5.3	5.8	6.1	6.3
OTHER.................	3.2	3.0	3.1	3.1	3.2	3.2	3.2	3.2
TOTAL...................	20.3	24.3	27.1	28.1	29.0	30.0	30.9	32.1
GENERATION..............	6.6	7.8	8.9	9.2	9.5	9.9	10.2	10.6

NOTE: TOTALS MAY NOT EQUAL SUM OF COMPONENTS DUE TO INDEPENDENT ROUNDING. FOR TABLE FOOTNOTES AND SOURCES SEE PAGE 219.

TABLE C.1.3. CONSUMPTION SUMMARY
CASE C: HIGH WORLD OIL PRICE
(QUADRILLION BTU PER YEAR)

	1975	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
RESIDENTIAL	9.571	9.335	9.104	9.236	9.143	9.132	9.099	9.059	9.022	9.005	8.997	8.994
STEAM COAL	0.091	0.065	0.080	0.082	0.071	0.078	0.076	0.074	0.073	0.071	0.069	0.068
NATURAL GAS	5.022	4.866	4.654	4.793	4.710	4.648	4.570	4.492	4.424	4.376	4.338	4.306
DISTILLATE(1)	1.923	1.417	1.375	1.303	1.230	1.279	1.268	1.248	1.223	1.196	1.166	1.135
LIQUID PETROLEUM GAS	0.528	0.539	0.536	0.570	0.590	0.556	0.555	0.549	0.542	0.535	0.528	0.521
ELECTRICITY	2.007	2.448	2.459	2.488	2.530	2.571	2.631	2.696	2.761	2.827	2.896	2.964
COMMERCIAL	5.513	5.892	5.818	5.867	6.182	6.400	6.504	6.555	6.566	6.560	6.574	6.593
STEAM COAL	0.135	0.095	0.107	0.122	0.086	0.097	0.094	0.092	0.089	0.086	0.084	0.082
NATURAL GAS	2.559	2.674	2.580	2.683	2.720	2.724	2.701	2.656	2.599	2.541	2.491	2.444
DISTILLATE(1)	0.622	0.556	0.540	0.511	0.670	0.723	0.740	0.746	0.745	0.740	0.734	0.727
LO-SULFUR RESIDUAL	0.506	0.566	0.470	0.376	0.490	0.531	0.544	0.548	0.547	0.543	0.539	0.534
LIQUID PETROLEUM GAS	0.093	0.095	0.095	0.101	0.090	0.080	0.078	0.076	0.073	0.071	0.069	0.067
ELECTRICITY	1.598	1.906	2.026	2.074	2.150	2.245	2.347	2.43	2.512	2.578	2.656	2.740
INDUSTRIAL(2)	18.503	20.185	19.513	16.876	17.365	18.533	18.629	18.802	19.186	19.912	20.372	21.054
STEAM COAL	1.619	1.388	1.570	1.626	1.501	1.777	1.801	1.885	1.996	2.118	2.236	2.345
METALLURGICAL COAL	2.178	1.793	1.647	1.057	1.132	1.261	1.300	1.323	1.336	1.353	1.360	1.376
NATURAL GAS	6.133	6.497	6.639	5.414	5.340	5.380	4.873	4.776	4.886	5.275	5.412	5.691
DISTILLATE	1.272	1.569	1.285	1.212	1.340	1.546	1.797	1.794	1.744	1.667	1.632	1.591
LO-SULFUR RESIDUAL	0.428	0.554	0.423	0.367	0.390	0.455	0.480	0.484	0.485	0.481	0.485	0.491
HI-SULFUR RESIDUAL	0.856	0.713	0.531	0.484	0.530	0.639	0.693	0.702	0.711	0.706	0.714	0.718
LIQUID PETROLEUM GAS	0.252	0.308	0.323	0.332	0.370	0.358	0.353	0.329	0.292	0.252	0.210	0.174
PET-CHEM FEEDSTOCK(3)	1.519	2.401	2.111	1.862	1.980	2.122	2.160	2.226	2.325	2.454	2.567	2.711
OTHER(4)	1.900	2.180	2.166	1.977	2.240	2.142	2.124	2.094	2.098	2.103	2.116	2.119
ELECTRICITY	2.346	2.781	2.817	2.545	2.620	2.851	3.047	3.189	3.322	3.504	3.642	3.838
TRANSPORTATION(5)	17.725	19.655	18.715	18.129	17.910	18.012	17.590	17.112	16.776	16.494	16.286	16.111
DISTILLATE	2.069	2.782	2.738	2.582	2.510	2.752	2.835	2.905	2.990	3.073	3.166	3.275
HI-SULFUR RESIDUAL	0.731	1.401	1.163	0.930	0.900	0.998	1.022	1.045	1.073	1.098	1.126	1.156
GASOLINE(6)	12.868	13.253	12.688	12.528	12.180	12.017	11.420	10.818	10.328	9.895	9.514	9.150
JET FUEL(7)	2.029	2.179	2.087	2.049	2.280	2.204	2.273	2.304	2.344	2.388	2.440	2.490
LIQUID PETROLEUM GAS	0.016	0.014	0.014	0.015	0.020	0.015	0.015	0.015	0.015	0.015	0.015	0.015
OTHER	0.000	0.014	0.014	0.014	0.010	0.014	0.014	0.014	0.014	0.014	0.014	0.014
ELECTRICITY	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010
ELECTRIC UTILITY FUEL	20.360	24.243	24.462	24.203	24.480	25.950	27.143	28.113	28.989	30.035	30.943	32.073
STEAM COAL	8.790	12.122	12.707	12.697	13.190	13.559	14.200	14.548	14.812	15.177	15.660	16.341
NATURAL GAS	3.240	3.807	3.764	3.336	3.440	3.308	2.066	2.143	2.363	2.546	3.045	3.373
DISTILLATE(8)	0.350	0.121	0.077	0.048	0.090	0.121	0.226	0.237	0.230	0.240	0.272	0.345
LO-SULFUR RESIDUAL(9)	2.860	1.611	1.251	0.980	0.780	1.247	2.232	2.183	2.004	1.963	1.621	1.466
HI-SULFUR RESIDUAL	NA	0.922	0.898	0.789	0.600	0.929	1.169	1.175	1.175	1.160	1.048	1.008
HYDRO/GEO/OTHER(10)	3.220	2.988	2.864	3.340	3.190	3.115	3.133	3.148	3.152	3.168	3.183	3.208
NUCLEAR	1.900	2.672	2.901	3.013	3.190	3.671	4.118	4.678	5.253	5.782	6.114	6.331
REFINERY FUEL(11)	2.769	2.787	2.304	2.190	2.480	2.218	2.339	2.295	2.242	2.200	2.140	2.104
NATURAL GAS	0.975	0.846	0.668	0.574	0.720	0.459	0.348	0.325	0.329	0.380	0.381	0.412
DISTILLATE	0.035	0.018	0.011	0.011	0.010	0.011	0.012	0.011	0.011	0.011	0.011	0.010
LO-SULFUR RESIDUAL	NA	NA	NA	NA	0.090	0.103	0.119	0.119	0.113	0.098	0.093	0.086
HI-SULFUR RESIDUAL	0.269	0.213	0.167	0.137	0.200	0.239	0.377	0.385	0.368	0.315	0.298	0.262
LIQUID PETROLEUM GAS	0.050	0.043	0.024	0.038	0.030	0.024	0.025	0.025	0.024	0.024	0.023	0.023
OTHER(12)	0.390	0.436	0.359	0.348	0.360	0.344	0.363	0.356	0.348	0.341	0.332	0.326
STILL GAS	1.050	1.231	1.073	1.085	1.080	1.038	1.095	1.074	1.050	1.030	1.002	0.985

NOTE: TOTALS MAY NOT EQUAL SUM OF COMPONENTS DUE TO INDEPENDENT ROUNDING. FOR TABLE FOOTNOTES AND SOURCES SEE PAGE 219.

TABLE C.1.4. PRICE SUMMARY
CASE C: HIGH WORLD OIL PRICE
(1982 DOLLARS PER MILLION BTU)

	1975	1980	1985	1986	1987	1988	1989	1990
WORLD OIL PRICE.........	20.70	39.32	33.81	38.24	41.13	42.92	44.94	47.69
RESIDENTIAL	5.95	8.33	10.43	11.41	11.96	12.03	12.31	12.66
NATURAL GAS...........	2.75	4.16	7.23	8.22	8.68	8.56	8.75	8.98
DISTILLATE(1).........	4.75	8.59	8.25	9.32	10.01	10.46	10.97	11.67
LIQUID PETROLEUM GAS..	4.11	6.67	7.39	8.31	8.89	9.21	9.56	10.09
ELECTRICITY	15.61	16.78	17.92	18.58	18.94	18.85	18.91	19.06
COMMERCIAL	6.27	8.38	11.02	12.03	12.61	12.74	13.07	13.48
NATURAL GAS...........	2.17	3.84	6.99	8.03	8.51	8.42	8.67	8.93
DISTILLATE(1).........	4.30	8.06	7.81	8.82	9.48	9.91	10.39	11.05
LO-SULFUR RESIDUAL....	4.13	5.32	6.04	6.83	7.36	7.74	8.07	8.62
LIQUID PETROLEUM GAS..	NA	6.67	7.41	8.34	8.92	9.23	9.59	10.12
ELECTRICITY	15.55	17.21	18.28	19.01	19.39	19.31	19.38	19.54
INDUSTRIAL(2)	3.37	5.44	7.47	8.26	8.70	8.80	9.05	9.38
STEAM COAL............	1.81	1.55	2.10	2.13	2.17	2.21	2.26	2.35
METALLURGICAL COAL....	2.80	2.51	2.57	2.59	2.61	2.64	2.66	2.72
NATURAL GAS...........	1.49	2.90	6.24	7.28	7.69	7.42	7.61	7.72
DISTILLATE............	4.24	7.99	7.71	8.71	9.36	9.79	10.27	10.92
LO-SULFUR RESIDUAL....	4.11	5.14	5.92	6.70	7.21	7.59	7.91	8.45
HI-SULFUR RESIDUAL....	2.93	NA	5.47	6.27	6.81	7.19	7.52	8.08
LIQUID PETROLEUM GAS..	3.83	6.34	7.12	8.01	8.57	8.86	9.20	9.70
PET-CHEM FEEDSTOCK(3).	NA	7.88	8.83	9.93	10.67	11.15	11.69	12.42
OTHER(4)..............	NA	NA	6.79	7.65	8.23	8.61	9.03	9.62
ELECTRICITY	9.42	11.67	14.84	15.41	15.75	15.71	15.80	15.98
TRANSPORTATION(5)	6.72	9.91	9.90	10.98	11.63	11.97	12.34	12.88
DISTILLATE............	5.85	8.39	8.19	9.25	9.95	10.40	10.90	11.59
HI-SULFUR RESIDUAL....	2.93	3.97	4.77	5.49	5.97	6.33	6.62	7.13
GASOLINE(6)...........	7.57	11.32	11.05	12.27	13.00	13.37	13.78	14.32
JET FUEL(7)...........	3.69	7.51	8.63	9.67	10.37	10.82	11.32	12.01
LIQUID PETROLEUM GAS..	NA	NA	7.08	7.97	8.53	8.84	9.18	9.69
ELECTRICITY	NA	NA	17.67	18.42	18.82	18.76	18.84	18.98
ELECTRIC UTILITY FUEL	2.04	1.84	2.28	2.44	2.50	2.51	2.56	2.65
STEAM COAL............	1.58	1.71	1.74	1.76	1.77	1.79	1.81	1.86
NATURAL GAS...........	1.14	2.80	6.34	7.40	7.83	7.46	7.63	7.67
DISTILLATE(8).........	3.28	7.22	7.75	8.75	9.39	9.82	10.30	10.95
LO-SULFUR RESIDUAL(9).	3.27	5.90	5.92	6.68	7.09	7.48	7.89	8.50
HI-SULFUR RESIDUAL....	NA	4.55	4.77	5.49	5.96	6.31	6.60	7.10
NUCLEAR...............	NA	.85	0.65	0.85	0.85	0.85	0.85	0.85
REFINERY FUEL	NA	NA	2.94	3.37	3.64	3.74	3.90	4.10
NATURAL GAS...........	NA	3.08	5.40	6.37	6.79	6.52	6.69	6.75
DISTILLATE............	NA	6.09	6.81	7.70	8.29	8.67	9.10	9.69
LO-SULFUR RESIDUAL....	NA	NA	5.20	5.91	6.38	6.72	7.00	7.50
HI-SULFUR RESIDUAL....	NA	4.89	4.55	5.25	5.72	6.06	6.35	6.84
LIQUID PETROLEUM GAS..	NA	NA	6.26	7.07	7.57	7.84	8.14	8.59
OTHER(10).............	NA	NA	6.68	7.54	8.12	8.50	8.93	9.51

NOTE: TOTALS MAY NOT EQUAL SUM OF COMPONENTS DUE TO INDEPENDENT ROUNDING. FOR TABLE FOOTNOTES AND SOURCES SEE PAGE 219.

TABLE C.3.1. NATIONAL MACROECONOMIC INDICATORS
CASE C: HIGH WORLD OIL PRICE

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
REAL GROSS NATIONAL PRODUCT(1).....	2408.8	2455.6	2411.2	2441.8	2552.0	2657.7	2744.9	2834.2	2910.0	2989.0	3081.7
GROSS NATIONAL PRODUCT DEFLATOR(2).	1.0931	1.1964	1.2681	1.3342	1.4067	1.4959	1.5884	1.6958	1.8187	1.9492	2.0882
REAL GROWTH(3).....................	-0.41	1.98	-1.81	1.16	4.51	4.14	3.28	3.25	2.67	2.71	3.10
INFLATION(3).......................	9.31	9.45	5.99	7.17	5.43	6.28	6.33	6.76	7.25	7.18	7.13
REAL PERSONAL DISPOSABLE INCOME(1).	1663.6	1704.6	1723.3	1743.4	1823.8	1887.6	1944.6	1988.5	2021.3	2067.6	2117.3
UNEMPLOYMENT RATE(3)...............	7.1	7.6	9.7	10.68	9.63	8.55	8.10	7.79	7.67	7.67	7.49
POPULATION(5)......................	222.138	224.175	226.219	228.160	230.305	232.344	234.480	236.597	238.760	240.846	242.977
REAL PERS DISP INCOME PER CAPITA(6)	7487.0	7603.9	7617.8	7640.9	7918.9	8124.0	8293.3	8404.7	8465.3	8584.8	8714.1
RESIDENTIAL HOUSING STARTS(5)......	1.292	1.084	1.060	1.455	1.663	1.860	1.866	1.884	1.865	1.805	1.751
AAA BOND RATE(3)...................	11.94	14.17	13.79	11.14	10.38	10.32	10.43	10.44	10.38	10.15	9.86
MORTGAGE RATE(3)...................	12.66	14.70	15.14	8.35	8.87	9.29	9.71	9.08	9.05	9.19	8.93
FEDERAL RESERVE PRODUCTION INDEX(4)	147.0	151.0	138.6	139.67	152.24	161.96	168.14	174.55	180.50	187.39	196.03

(1) BILLIONS OF 1979 DOLLARS.
(2) INDEX EQUAL TO 1.0 IN 1979.
(3) PERCENTAGE.
(4) INDEX EQUAL TO 100 IN 1967.
(5) MILLIONS OF UNITS.
(6) 1979 DOLLARS.

NOTE: ENTRIES FOR 1980, 1981 AND 1982 ARE HISTORICAL DATA.

SOURCES: ON PAGE 222, SEE 9, PAGE 164, TABLE B-2; 9, PAGE 166, TABLE B-3; 9, PAGE 191, TABLE B-24; 9, PAGE 201, TABLE B-33; 9, PAGE 216, TABLE B-47; 9, PAGE 240, TABLE B-67; AND 9, PAGE 210, TABLE B-42.

TABLE C.4.1. RESIDENTIAL SECTOR FUEL CONSUMPTION BY END-USE SERVICE
CASE C: HIGH WORLD OIL PRICE
(TRILLIONS OF BTU PER YEAR)

	1980	1985	1986	1987	1988	1989	1990
SPACE HEATING							
ELECTRICITY(1).....	281.	244.	258.	271.	284.	297.	310.
NATURAL GAS........	3225.	2982.	2903.	2833.	2781.	2736.	2697.
FUEL OIL...........	1172.	1034.	1015.	992.	966.	938.	908.
LIQUID GAS.........	390.	399.	395.	390.	385.	380.	374.
COAL...............	65.	76.	74.	73.	71.	69.	68.
MARKET TOTAL.......	5054.	4734.	4646.	4560.	4486.	4420.	4357.
WOOD...............	818.	1132.	1161.	1183.	1197.	1204.	1209.
WATER HEATING							
ELECTRICITY........	286.	316.	325.	334.	344.	354.	364.
NATURAL GAS........	1055.	1028.	1029.	1032.	1037.	1042.	1049.
FUEL OIL...........	244.	234.	233.	231.	230.	229.	228.
LIQUID GAS.........	149.	156.	154.	152.	150.	148.	147.
MARKET TOTAL.......	1734.	1734.	1741.	1749.	1761.	1774.	1787.
AIR CONDITIONING							
ELECTRICITY........	351.	378.	386.	393.	402.	411.	420.
NATURAL GAS........	12.	12.	12.	13.	13.	13.	13.
MARKET TOTAL.......	363.	391.	398.	406.	415.	424.	433.
OTHER END-USES(2)							
ELECTRICITY........	1610.	1693.	1728.	1762.	1797.	1834.	1870.
NATURAL GAS........	574.	548.	547.	546.	546.	547.	547.
MARKET TOTAL.......	2185.	2241.	2275.	2308.	2343.	2380.	2418.
FOR ALL END USES							
ELECTRICITY........	2448.	2631.	2697.	2761.	2828.	2896.	2964.
NATURAL GAS........	4866.	4570.	4492.	4424.	4376.	4338.	4306.
FUEL OIL...........	1417.	1268.	1248.	1223.	1196.	1166.	1135.
LIQUID GAS.........	539.	555.	549.	542.	535.	528.	520.
COAL...............	65.	76.	74.	73.	71.	69.	68.
MARKET TOTAL.......	9335.	9100.	9059.	9023.	9005.	8997.	8994.
WOOD...............	818.	1132.	1161.	1183.	1197.	1204.	1209.

(1) ELECTRIC SPACE HEATING INCLUDES BOTH ELECTRIC RESISTANCE AND HEAT PUMPS.
(2) SOME OF THE MAJOR USES ARE LIGHTING, COOKING, REFRIGERATION, WASHING, AND DRYING.
NOTE: ENTRIES FOR 1980 ARE A COMBINATION OF HISTORICAL AND ESTIMATED VALUES.
SOURCES: ON PAGE 222, SEE 1, PAGE 15; AND 19, PAGE 101, TABLE A4.

TABLE C.4.2. COMMERCIAL SECTOR ENERGY CONSUMPTION AND FLOORSPACE BY BUILDING CATEGORY
CASE C: HIGH WORLD OIL PRICE
(CONSUMPTION IN QUADRILLION BTU PER YEAR, FLOORSPACE IN BILLIONS OF SQUARE FEET)

		1980	1985	1986	1987	1988	1989	1990
ALL CATEGORIES...	ALL FUELS.......	5.892	6.504	6.555	6.566	6.560	6.574	6.593
	NATURAL GAS.....	2.674	2.701	2.656	2.599	2.541	2.491	2.444
	ELECTRICITY.....	1.907	2.347	2.437	2.512	2.578	2.657	2.740
	FUEL OIL(1).....	1.122	1.284	1.294	1.292	1.283	1.274	1.260
	OTHER FUELS(2)..	0.190	0.172	0.168	0.163	0.158	0.153	0.149
	FLOORSPACE......	44.75	51.15	52.61	53.88	54.99	56.30	57.72
WAREHOUSE........	ALL FUELS.......	0.826	0.923	0.935	0.942	0.946	0.953	0.961
	NATURAL GAS.....	0.376	0.374	0.367	0.358	0.350	0.342	0.335
	ELECTRICITY.....	0.254	0.320	0.332	0.342	0.352	0.363	0.375
	FUEL OIL(1).....	0.167	0.203	0.211	0.216	0.220	0.224	0.228
	OTHER FUELS(2)..	0.028	0.026	0.025	0.025	0.024	0.023	0.023
	FLOORSPACE......	6.29	7.28	7.49	7.69	7.88	8.08	8.30
INSTITUTION(3)...	ALL FUELS.......	0.675	0.696	0.690	0.678	0.663	0.652	0.641
	NATURAL GAS.....	0.392	0.356	0.344	0.329	0.315	0.303	0.292
	ELECTRICITY.....	0.108	0.134	0.139	0.143	0.147	0.152	0.157
	FUEL OIL(1).....	0.155	0.190	0.192	0.190	0.187	0.183	0.179
	OTHER FUELS(2)..	0.019	0.017	0.016	0.015	0.015	0.014	0.013
	FLOORSPACE......	1.65	1.89	1.94	1.99	2.03	2.07	2.12
OFFICE...........	ALL FUELS.......	1.935	2.159	2.185	2.198	2.203	2.216	2.231
	NATURAL GAS.....	0.755	0.762	0.749	0.733	0.717	0.702	0.689
	ELECTRICITY.....	0.726	0.893	0.930	0.960	0.985	1.015	1.048
	FUEL OIL(1).....	0.393	0.447	0.452	0.452	0.450	0.448	0.444
	OTHER FUELS(2)..	0.062	0.056	0.055	0.053	0.052	0.051	0.049
	FLOORSPACE......	15.74	18.06	18.60	19.05	19.44	19.91	20.42
HOTEL AND MOTEL..	ALL FUELS.......	0.299	0.337	0.339	0.338	0.336	0.337	0.337
	NATURAL GAS.....	0.142	0.148	0.145	0.141	0.138	0.135	0.131
	ELECTRICITY.....	0.114	0.145	0.150	0.155	0.158	0.163	0.168
	FUEL OIL(1).....	0.033	0.035	0.034	0.033	0.032	0.031	0.030
	OTHER FUELS(2)..	0.010	0.009	0.009	0.009	0.008	0.008	0.008
	FLOORSPACE......	2.12	2.41	2.49	2.55	2.59	2.66	2.72
RETAIL/WHOLESALE.	ALL FUELS.......	1.552	1.780	1.801	1.811	1.816	1.825	1.837
	NATURAL GAS.....	0.733	0.787	0.783	0.774	0.765	0.757	0.751
	ELECTRICITY.....	0.545	0.678	0.706	0.731	0.753	0.778	0.805
	FUEL OIL(1).....	0.223	0.268	0.265	0.260	0.253	0.247	0.239
	OTHER FUELS(2)..	0.051	0.048	0.047	0.046	0.045	0.044	0.043
	FLOORSPACE......	13.18	15.33	15.82	16.25	16.63	17.08	17.56
MISCELLANEOUS(4).	ALL FUELS.......	0.606	0.609	0.605	0.600	0.595	0.591	0.587
	NATURAL GAS.....	0.276	0.274	0.269	0.263	0.257	0.251	0.246
	ELECTRICITY.....	0.160	0.177	0.180	0.181	0.183	0.185	6.187
	FUEL OIL(1).....	0.151	0.142	0.141	0.141	0.141	0.141	0.141
	OTHER FUELS(2)..	0.019	0.016	0.016	0.015	0.014	0.014	0.913
	FLOORSPACE......	5.76	6.19	6.28	6.36	6.43	6.51	6.60

(1) FUEL OIL CONSISTS OF LOW SULFUR RESIDUAL OIL AND DISTILLATE OIL.
(2) OTHER FUELS CONSIST OF LIQUID PETROLEUM GASES AND COAL.
(3) INCLUDES MAINLY HEALTH FACILITIES AND PENAL INSTITUTIONS.
(4) INCLUDES MAINLY RELIGIOUS FACILITIES, ASSEMBLEY HALLS, PARKING GARAGES, AND RECREATIONAL FACILITIES.

NOTE: ENTRIES FOR 1980 ARE A COMBINATION OF HISTORICAL AND ESTIMATED VALUES.
SOURCES: ON PAGE 222, SEE 1, PAGE 16.

TABLE C.4.3. INDUSTRIAL SECTOR ENERGY CONSUMPTION
CASE C: HIGH WORLD OIL PRICE
(TRILLIONS OF BTU PER YEAR)

	1980	1985	1986	1987	1988	1989	1990
COAL....................	1387.88	1800.63	1885.19	1996.45	2117.53	2235.70	2345.39
NATURAL GAS.............	6497.36	4873.40	4775.75	4885.59	5274.62	5412.02	5686.42
(RAW MATERIALS(1).....	650.77	470.90	454.11	454.66	470.85	477.90	483.46)
DISTILLATE..............	1568.69	1797.22	1794.30	1744.43	1666.78	1631.73	1590.92
HI-SULFUR RESIDUAL......	713.20	692.83	701.94	710.84	705.74	713.80	718.25
LO-SULFUR RESIDUAL......	553.58	480.49	483.53	484.85	481.29	484.56	490.77
ELECTRICITY.............	2780.85	3046.84	3189.49	3321.64	3504.05	3641.66	3837.83
LIQUID PETROLEUM GAS....	307.88	353.12	328.59	291.93	252.22	209.83	173.67
PET-CHEM FEEDSTOCKS(2)..	2401.48	2159.98	2225.82	2324.69	2453.72	2567.46	2709.12
METALLUPGICAL COAL......	1793.34	1300.23	1322.84	1335.63	1352.77	1359.54	1375.60
OTHER(3)................	2180.32	2123.98	2094.12	2090.30	2103.33	2115.63	2120.01
TOTAL ENERGY............	20184.58	18628.71	18801.57	19186.34	19912.02	20371.91	21047.97

(1) NATURAL GAS CONSUMED AS A FEEDSTOCK BY THE CHEMICAL INDUSTRY (ALREADY INCLUDED IN THE NATURAL GAS TOTAL).

(2) CONSISTS OF STILL GAS USED FOR FEEDSTOCK PUROPSES, NAPTHAS LESS THAN 400 DEGREES, OTHER FUELS GREATER THAN 400 DEGREES, AND LIQUID PETROLEUM GASES USED FOR GAS UTILITY FUEL AND FOR CHEMICAL FEEDSTOCKS.

(3) ASPHALT, PETROLEUM COKE, LUBRICANTS, INDUSTRIAL KEROSENE, WAXES AND MISCELLANEOUS PETROLEUM PRODUCTS.

NOTE: INDUSTRIAL SECTOR TOTAL DIFFER FROM THOSE SHOWN IN THE "MONTHLY ENERGY REVIEW" BY EXCLUDING ELECTRICITY LOSSES, GASOLINE, NATURAL GAS USED AS A LEASE AND PLANT FUEL, AND ALL REFINERY FUELS EXCEPT COAL AND ELECTRICITY, AND BY INCLUDING LUBRICANTS CONSUMED BY THE TRANSPORTATION SECTOR. IN 1980 ONLY, THE RESIDUAL AND DISTILLATE DETAIL HAS BEEN CONVERTED TO THE NEW BASIS FOR CONSISTENCY WITH THE PETROLEUM BALANCE TABLE AND WITH 1980 FUEL DETAIL USED IN THE "SHORT-TERM ENERGY OUTLOOK."

NOTE: ENTRIES FOR 1980 ARE HISTORICAL DATA.

SOURCES: ON PAGE 222, SEE 1, PAGE 17; 15, PAGE 11, TABLE 5; AND 15, PAGE 127, TABLE 55.

TABLE C.4.4. TRANSPORTATION SECTOR ENERGY CONSUMPTION BY MODE
CASE C: HIGH WORLD OIL PRICE

	1980	1985	1986	1987	1988	1989	1990
FUEL CONSUMPTION, ALL MODES							
GASOLINE(1)	13.253	11.420	10.818	10.320	9.895	9.514	9.150
DISTILLATE(1)	2.782	2.835	2.905	2.990	3.073	3.166	3.275
JET FUEL(1)	2.179	2.273	2.304	2.344	2.388	2.440	2.490
RESIDUAL(1)	1.401	1.022	1.045	1.073	1.098	1.126	1.156
LIQUID GAS(1)	0.014	0.015	0.015	0.015	0.015	0.015	0.015
FUEL USE IN LIGHT DUTY VEHICLES							
SALES:LIGHT DUTY VEHICLES(3)	10.750	13.254	13.644	14.123	14.702	15.081	15.004
VEHICLE-MILES:TOTAL(2)	1383.	1564.	1586.	1608.	1630.	1657.	1685.
FLEET-MILES PER GALLON:TOTAL	14.17	17.50	18.68	19.77	20.82	21.89	23.00
PERCENT FLEET VMT DIESEL	0.010	0.023	0.029	0.035	0.043	0.051	0.061
VEHICLE-MILES:GAS(2)	1368.	1528.	1540.	1551.	1560.	1572.	1581.
FLEET-MILES PER GALLON:GAS	13.95	17.23	18.34	19.35	20.30	21.26	22.23
FUEL USE:GAS(4)	98.080	88.650	83.964	80.181	76.866	73.962	71.126
VEHICLE-MILES:DIESEL(2)	14.	36.	46.	57.	70.	85.	103.
FLEET-MILES PER GALLON:DIESEL	25.34	28.45	29.72	30.82	31.80	32.81	33.87
FUEL USE:DIESEL(4)	0.564	1.280	1.549	1.849	2.186	2.587	3.048
FUEL USE IN HEAVY TRUCKS							
SALES:HEAVY TRUCKS(3)	0.487	0.644	0.675	0.706	0.736	0.756	0.734
VEHICLE-MILES:TOTAL(2)	105.	120.	123.	127.	130.	134.	138.
FLEET-MILES PER GALLON:TOTAL	5.82	6.85	7.07	7.29	7.52	7.75	7.94
PERCENT FLEET VMT DIESEL	0.591	0.656	0.669	0.683	0.697	0.710	0.722
VEHICLE-MILES:GAS(2)	43.	41.	41.	40.	40.	39.	38.
FLEET-MILES PER GALLON:GAS	6.84	8.29	8.60	8.92	9.25	9.56	9.78
FUEL USE:GAS(4)	6.266	5.004	4.747	4.517	4.277	4.055	3.908
VEHICLE-MILES:DIESEL(2)	62.	79.	83.	87.	91.	95.	99.
FLEET-MILES PER GALLON:DIESEL	5.09	6.09	6.31	6.54	6.77	7.01	7.23
FUEL USE:DIESEL(4)	12.168	12.966	13.083	13.268	13.415	13.564	13.751
FUEL USE IN AIR							
REVENUE PASSENGER-MILES(3)	265.	330.	341.	353.	365.	379.	393.
AVERAGE FLIGHT SIZE	158.	167.	169.	171.	172.	174.	177.
LOAD FACTOR	0.62	0.64	0.64	0.65	0.65	0.65	0.66
FUEL BURNED PER SEAT-MILE(5)	0.023	0.022	0.021	0.021	0.021	0.020	0.020
TOTAL JET FUEL(4)	16.543	18.549	18.809	19.135	19.488	19.917	20.321
FUEL USE IN OTHER							
NON-HWY DSL(1)	4.438	4.689	4.771	4.853	4.923	4.994	5.076
RESIDUAL(1)	1.550	1.741	1.778	1.827	1.870	1.917	1.968

(1) QUADRILLION BTU PER YEAR.
(2) BILLIONS PER YEAR.
(3) MILLIONS PER YEAR.
(4) BILLIONS OF GALLONS PER YEAR.
(5) GALLONS PER YEAR.
NOTE: ENTRIES FOR 1980 ARE A COMBINATION OF HISTORICAL AND ESTIMATED VALUES.

TABLE C.5.1. ELECTRIC UTILITY FUEL PRICES AND CONSUMPTION
CASE C: HIGH WORLD OIL PRICE
(1982 DOLLARS PER MILLION BTU; TRILLIONS OF BTU PER YEAR)

YEARS	COAL	NATURAL GAS	DISTILLATE	LO-S RESID	HI-S RESID	FOSSIL FUEL	NUCLEAR	HYDRO	ALL FUELS
FUEL PRICES									
1980	1.71	2.88	7.22	5.90	4.55	NA	NA	--	NA
1985	1.74	6.34	7.69	5.92	4.77	2.93	0.85	--	2.28
1986	1.76	7.40	8.73	6.68	5.49	3.18	0.85	--	2.44
1987	1.77	7.83	9.36	7.09	5.96	3.31	0.85	--	2.50
1988	1.79	7.46	9.81	7.48	6.31	3.34	0.85	--	2.51
1989	1.81	7.63	10.27	7.89	6.59	3.42	0.85	--	2.56
1990	1.86	7.67	10.90	8.51	7.10	3.53	0.85	--	2.65
FUEL CONSUMPTION									
1980	12122.	3807.	121.	1611.	922.	18583.	2672.	2988.	24243.
1985	14200.	2066.	226.	2232.	1169.	19893.	4118.	3133.	27143.
1986	14548.	2143.	237.	2183.	1175.	20286.	4678.	3148.	28113.
1987	14812.	2363.	230.	2004.	1175.	20584.	5253.	3152.	28989.
1988	15177.	2546.	240.	1963.	1160.	21085.	5782.	3168.	30035.
1989	15660.	3045.	272.	1621.	1048.	21646.	6114.	3183.	30943.
1990	16341.	3373.	345.	1466.	1008.	22534.	6331.	3208.	32073.

NA=NOT AVAILABLE.
--=NOT APPLICABLE.
NOTE: ENTRIES FOR 1980 ARE HISTORICAL DATA.
SOURCES: ON PAGE 222, SEE 1; 2, PP 160-170, TABLES B1, B2, B3, AND B4; 2, PP 253-255, TABLE C9; 2, PP 262-263, TABLE C13; 2, PP 270-271, TABLE C17; AND 2, PP 290-291, TABLE C27.

TABLE C.5.2. END-USE ELECTRICITY PRICES AND CONSUMPTION
CASE C: HIGH WORLD OIL PRICE
(1982 MILLS PER KWH; BILLION KWH PER YEAR)

YEARS	RESIDENTIAL	COMMERCIAL	TRANSPORTATION	INDUSTRIAL	AVG./TOTAL
END-USE PRICES					
1980	57.25	58.72	NA	39.82	50.82
1985	61.14	62.38	60.29	50.65	57.52
1986	63.39	64.86	62.85	52.57	59.68
1987	64.61	66.17	64.20	53.73	60.84
1988	64.32	65.90	63.99	53.59	60.56
1989	64.52	66.13	64.29	53.90	60.78
1990	65.05	66.67	64.76	54.54	61.29
END-USE CONSUMPTION					
1980	717.50	558.91	0.00	815.06	2091.47
1985	771.02	687.81	3.05	893.03	2354.91
1986	790.32	714.26	3.05	934.84	2442.46
1987	809.21	736.31	3.05	973.57	2522.14
1988	828.69	755.65	3.05	1027.04	2614.42
1989	848.79	778.62	3.05	1067.37	2697.82
1990	868.79	803.19	3.05	1124.83	2799.86

NA=NOT AVAILABLE.
NOTE: ENTRIES FOR 1980 ARE HISTORICAL DATA.
SOURCES: ON PAGE 222, SEE 1, PP 15-18; AND 2, PP 229-40, TABLES C1, C2, C3, AND C4.

TABLE C.5.3. ELECTRIC UTILITY CAPACITY AND GENERATION
CASE C: HIGH WORLD OIL PRICE
(CAPACITY IN GIGAWATTS; GENERATION IN BILLION KWH)

CAPACITY TYPE		1980	1985	1986	1987	1988	1989	1990
COAL STEAM	CAPACITY...	176.58	224.96	233.92	238.89	246.92	255.00	265.72
	GENERATION.	943.4	1149.9	1188.2	1216.2	1231.7	1294.2	1352.9
NATURAL GAS STEAM	CAPACITY...	40.99	40.99	40.99	40.99	40.99	40.99	40.99
	GENERATION.	150.2	63.4	61.0	62.3	64.5	63.5	134.7
OIL STEAM	CAPACITY...	32.27	35.07	35.07	35.07	35.12	35.12	35.12
	GENERATION.	113.0	118.1	119.7	119.6	119.3	119.2	121.2
NG/COAL STEAM	CAPACITY...	32.31	32.46	32.46	32.46	32.46	32.46	32.46
	GENERATION.	123.5	105.6	103.4	102.3	103.4	105.8	110.3
OIL/COAL STEAM	CAPACITY...	40.18	40.18	40.18	40.18	40.18	40.18	40.18
	GENERATION.	149.5	152.7	152.6	152.8	153.1	156.7	161.2
NG/OIL STEAM	CAPACITY...	69.81	69.81	69.81	69.81	69.81	69.81	69.81
	GENERATION.	233.0	238.3	240.2	243.1	242.9	247.0	179.5
NG COMBINED CYCLE	CAPACITY...	4.45	4.45	4.45	4.45	4.45	4.45	4.45
	GENERATION.	12.7	23.7	24.4	23.8	27.8	27.5	27.4
OIL COMBINED CYCLE	CAPACITY...	3.34	3.49	3.49	3.49	3.49	3.49	3.49
	GENERATION.	2.3	7.5	7.8	7.9	8.7	5.9	7.5
NATURAL GAS TURBINE	CAPACITY...	4.64	5.06	5.06	5.06	5.06	5.06	5.06
	GENERATION.	5.3	3.4	3.9	4.5	5.1	6.4	8.4
OIL TURBINE	CAPACITY...	46.51	48.09	48.20	48.28	48.34	48.51	48.58
	GENERATION.	5.6	8.7	9.5	9.8	9.4	10.9	14.0
NG/OIL TURBINE	CAPACITY...	52.62	52.68	52.68	52.68	52.68	52.68	52.68
	GENERATION.	8.1	10.0	10.0	8.5	12.7	15.4	18.7
NUCLEAR	CAPACITY...	50.18	77.94	88.30	99.06	106.37	112.76	113.93
	GENERATION.	251.0	387.1	439.7	493.8	543.5	574.8	595.1
PUMP STORAGE HYDRO(1)	CAPACITY...	88.20	14.25	15.82	18.66	19.50	20.28	20.54
	GENERATION.	282.0	12.1	14.8	18.1	20.2	25.0	30.3
PONDAGE HYDRO(1)	CAPACITY...	--	72.05	72.44	72.52	72.65	72.85	72.92
	GENERATION.	--	302.6	304.1	304.5	306.0	307.5	309.9
DOMESTIC TOTAL	CAPACITY...	642.08	721.48	742.87	761.60	778.02	793.64	805.93
	GENERATION.	2287.6	2583.1	2679.3	2767.2	2868.3	2959.8	3071.1
CANADIAN IMPORTS	GENERATION.	26.72	94.29	96.73	98.90	101.32	104.01	107.10

(1) IN 1980, PONDAGE HYDROPOWER IS INCLUDED IN PUMP STORAGE HYDROPOWER.
--=NOT APPLICABLE.
NOTE: "CAPACITY" INDICATES THE POTENTIAL AMOUNT OF ELECTRICAL POWER THAT COULD BE GENERATED IF POWERPLANTS OPERATED NONSTOP.
NOTE: "GENERATION" INDICATES THE AMOUNT OF ELECTRICITY PRODUCED FROM EACH CAPACITY TYPE.
NOTE: ENTRIES FOR 1980 ARE A COMBINATION OF HISTORICAL AND ESTIMATED VALUES.
SOURCES: ON PAGE 222, SEE 10, PP 273-287, TABLE 9; AND 11, PAGE 1, TABLE 1.

TABLE C.5.4. SCHEDULED ELECTRIC UTILITY CAPACITY ADDITIONS
CASE C: HIGH WORLD OIL PRICE
(CAPACITY IN MEGAWATTS)

NEW CAPACITY TYPE	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	TOTAL
COAL STEAM........	13633.	9499.	9821.	7023.	8088.	10524.	4918.	6198.	7753.	9537.	9269.	96261.
OIL STEAM.........	987.	1895.	0.	0.	0.	10.	0.	0.	50.	0.	0.	2942.
NG/COAL STEAM.....	570.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	570.
OIL CC............	0.	0.	90.	60.	0.	0.	0.	0.	0.	0.	0.	150.
NG TURBINE........	76.	375.	8.	0.	0.	0.	0.	0.	0.	0.	0.	459.
OIL TURBINE.......	978.	238.	230.	320.	82.	154.	73.	97.	54.	140.	94.	2460.
NG/OIL TURBINE....	0.	60.	0.	0.	0.	0.	0.	0.	0.	0.	0.	60.
NUCLEAR...........	1819.	3912.	3296.	5250.	9269.	9183.	14455.	4910.	10063.	2355.	0.	64512.
PUMP STORAGE......	256.	0.	997.	531.	0.	1050.	2050.	2325.	0.	955.	150.	8314.
PONDAGE HYDRO.....	1373.	259.	772.	923.	679.	482.	187.	103.	232.	74.	0.	5083.
TOTAL NEW CAPACITY	19692.	16237.	15214.	14107.	18118.	21403.	21683.	13633.	18152.	13061.	9513.	180806.

SOURCES: ON PAGE 222, SEE 10, PP 27-259, TABLE 7; AND 10, PP 273-287, TABLE 9.

TABLE C.5.5. SUMMARY OF COMPONENTS OF ELECTRICITY PRICE
CASE C: HIGH WORLD OIL PRICE
(1982 MILLS PER KWH)

	1980	1985	1986	1987	1988	1989	1990
PRIVATE UTILITIES							
CAPITAL COMPONENT...	10.21	10.24	10.55	10.38	10.54	10.25	9.90
FUEL COMPONENT......	26.14	29.20	30.98	31.69	31.61	32.03	32.88
O&M COMPONENT(1)....	8.33	8.74	8.76	8.77	8.73	8.70	8.60
OTHERS(2)...........	12.22	11.71	11.94	12.65	12.26	12.39	12.37
TOTAL PRICE.........	56.90	59.89	62.23	63.49	63.14	63.37	63.75
PUBLIC & PRIVATE UTILITIES							
CAPITAL COMPONENT...	10.51	10.72	10.89	10.69	10.70	10.36	10.08
FUEL COMPONENT......	25.32	28.07	29.81	30.50	30.53	31.03	31.97
O&M COMPONENT(1)....	8.06	8.47	8.49	8.50	8.46	8.44	8.34
OTHERS(2)...........	10.67	10.27	10.49	11.17	10.86	10.96	10.90
TOTAL PRICE.........	54.55	57.52	59.68	60.87	60.56	60.78	61.29

(1) OPERATION AND MAINTENANCE.
(2) INCLUDES DEPRECIATION AND TAXES.
NOTE: ENTRIES FOR 1980 ARE A COMBINATION OF HISTORICAL AND ESTIMATED VALUES.

TABLE C.6.1. ANNUAL SUPPLY AND DISPOSITION OF PETROLEUM
CASE C: HIGH WORLD OIL PRICE
(MILLIONS OF BARRELS PER DAY)

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
SUPPLY											
PRODUCTION											
CRUDE OIL	8.60	8.57	8.67	8.64	8.91	9.04	9.20	9.26	9.26	9.14	8.67
NORTH SLOPE	1.52	1.53	1.61	1.63	1.70	1.71	1.78	1.78	1.78	1.82	1.73
SUBARCTIC(1)	7.08	7.05	7.06	7.00	7.19	7.29	7.33	7.34	7.30	7.07	6.66
NATURAL GAS LIQUIDS	1.57	1.61	1.55	1.54	1.37	1.24	1.23	1.25	1.29	1.34	1.39
OTHER DOMESTIC(2)	0.04	0.05	0.05	0.05	0.02	0.04	0.09	0.14	0.19	0.24	0.29
PROCESSING GAIN	0.60	0.51	0.53	0.49	0.51	0.53	0.52	0.51	0.50	0.49	0.49
TOTAL PRODUCTION	10.81	10.74	10.81	10.72	10.78	10.81	10.95	11.01	11.06	10.97	10.55
IMPORTS(3)											
CRUDE OIL	5.26	4.40	3.46	3.75	4.22	4.79	4.38	4.02	3.77	3.55	3.80
REFINED PRODUCTS(4)	1.65	1.60	1.58	1.76	2.02	2.04	2.04	2.04	2.02	2.02	2.02
TOTAL IMPORTS	6.91	6.00	5.04	5.51	6.24	6.83	6.41	6.06	5.79	5.56	5.82
EXPORTS											
CRUDE OIL	0.29	0.23	0.24	0.23	0.25	0.25	0.25	0.25	0.25	0.25	0.25
REFINED PRODUCTS(4)	0.26	0.37	0.58	0.55	0.62	0.62	0.62	0.62	0.62	0.62	0.62
TOTAL EXPORTS	0.54	0.59	9.82	0.78	0.87	0.87	0.87	0.87	0.87	0.87	0.87
NET IMPORTS	6.37	5.40	4.23	4.72	5.37	5.96	5.54	5.19	4.92	4.69	4.95
PRIMARY STOCK CHANGES(5)											
NET WITHDRAWALS	-0.09	0.18	0.32	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SPR FILL RATE ADDITIONS(6)	-0.05	-0.34	-0.17	-0.21	-0.15	-0.15	-0.15	-0.15	-0.15	-0.15	-0.15
TOTAL PRIMARY SUPPLY	17.04	15.98	15.18	15.37	16.00	16.62	16.34	16.05	15.83	15.51	15.35
PRODUCT SUPPLIED											
MOTOR GASOLINE	6.86	6.59	6.54	6.36	6.27	5.96	5.65	5.39	5.17	4.97	4.78
DISTILLATE FUEL OIL	2.97	2.83	2.67	2.75	3.03	3.23	3.27	3.27	3.26	3.28	3.33
RESIDUAL FUEL OIL	2.56	2.09	1.69	1.73	2.24	2.90	2.89	2.82	2.77	2.58	2.49
OTHER PRODUCTS(7)	5.11	4.83	4.66	4.83	4.75	4.82	4.83	4.86	4.91	4.95	5.02
TOTAL RECLASSIFIED(8)	-0.44	-0.27	-0.31	-0.30	-0.28	-0.29	-0.29	-0.28	-0.28	-0.27	-0.27
TOTAL PRODUCT SUPPLIED	17.06	16.06	15.25	15.37	16.00	16.62	16.35	16.05	15.83	15.51	15.35
DISCREPANCY	-0.02	-0.08	-0.07	0.00	-0.00	-0.00	-0.01	-0.00	0.00	-0.00	-0.00
NET DISPOSITION	17.04	15.98	15.18	15.37	16.00	16.62	16.34	16.05	15.83	15.51	15.35

(1) INCLUDES LOWER-48 STATES AND SOUTHERN ALASKA.
(2) OTHER DOMESTIC REPRESENTS OTHER HYDROCARBON INPUT.
(3) INCLUDES IMPORTS FOR THE STRATEGIC PETROLEUM RESERVE.
(4) CONSISTS OF NATURAL GAS PLANT LIQUIDS, UNFINISHED OILS, AND REFINED PRODUCT IMPORTS.
(5) EXCLUDES CRUDE OIL FOR THE STRATEGIC PETROLEUM RESERVE.
(6) ADDITIONS TO THE STRATEGIC PETROLEUM RESERVE (SHOWN AS NEGATIVE ENTRIES).
(7) COMPOSED OF JET FUEL, LIQUEFIED GASES, AND OTHER PRODUCTS.
(8) PETROLEUM PRODUCTS REPROCESSED INTO OTHER PRODUCT CATEGORIES.

NOTE: IN 1980, GASOLINE SUPPLIED HAS BEEN ADJUSTED TO CORRECT UNDERESTIMATION OF PRODUCT SUPPLIED. DISTILLATE AND RESIDUAL FUEL OIL HAVE BEEN RESTATED INTO THE NEW BASIS FOR COMPARABILITY PURPOSES.

NOTE: ENTRIES FOR 1980 ARE A COMBINATION OF HISTORICAL AND ESTIMATED VALUES.

SOURCES: ON PAGE 222, SEE 4, PAGE 6, TABLE 1; AND 20, PAGE 18, TABLE 7.

TABLE C.7.1. NATURAL GAS SUPPLY/DEMAND BALANCE
CASE C: HIGH WORLD OIL PRICE
(TRILLION BTU PER YEAR; 1982 DOLLARS PER MILLION BTU)

	1980	1985	1986	1987	1988	1989	1990
LOWER-48 ONSHORE SUPPLY	14435.	11682.	11392.	11463.	12060.	12832.	13797.
LOWER-48 OFFSHORE SUPPLY	5477.	3911.	4016.	4189.	4173.	4015.	3680.
TOTAL DOMESTIC SUPPLY	19912.	15593.	15408.	15652.	16233.	16847.	17477.
CATEGORY 102 (NEW GAS)	3439.	6482.	7166.	8048.	8984.	10113.	10893.
CATEGORY 104 (OLD INTERSTATE GAS)	8910.	5730.	4980.	4360.	3850.	3440.	3090.
CATEGORY 105 (OLD INTRASTATE GAS)	6899.	3050.	2750.	2550.	2370.	2110.	2000.
CATEGORY 107 (DEEP GAS)	664.	331.	511.	694.	1029.	1184.	1494.
SUPPLEMENTAL GAS(1)	159.	0.	0.	0.	0.	0.	0.
IMPORTS	957.	1230.	1230.	1230.	1230.	1230.	1230.
TOTAL SUPPLY	21028.	16823.	16638.	16882.	17463.	18077.	18707.
LEASE AND PLANT FUEL(2)	1045.	1169.	1156.	1174.	1218.	1264.	1311.
TRANSPORTATION LOSS(3)	647.	1096.	1089.	1105.	1130.	1145.	1167.
CONSUMPTION BY SECTOR							
RESIDENTIAL	4866.	4570.	4492.	4424.	4376.	4338.	4306.
COMMERCIAL(4)	2674.	2701.	2656.	2599.	2541.	2491.	2444.
REFINERY	846.	348.	325.	329.	380.	381.	412.
ELECTRIC UTILITY	3807.	2066.	2143.	2363.	2546.	3045.	3373.
INDUSTRIAL(5)	6497.	4873.	4776.	4886.	5275.	5412.	5694.
TOTAL END-USE CONSUMPTION	18690.	14558.	14392.	14600.	15118.	15666.	16229.
DISCREPANCY(6)	-646.	0.	0.	0.	0.	0.	0.
WELLHEAD PRICES							
AVERAGE PRICE	1.79	4.26	5.22	5.70	5.50	5.66	5.70
CATEGORY 102 (NEW GAS)	2.69	5.54	6.63	6.85	6.39	6.42	6.35
CATEGORY 104 (OLD INTERSTATE GAS)	1.32	2.22	2.46	2.80	2.72	2.75	2.73
CATEGORY 105 (OLD INTRASTATE GAS)	1.67	5.24	6.26	6.70	6.26	6.31	6.26
CATEGORY 107 (DEEP GAS)	4.78	5.54	6.63	6.85	6.39	6.42	6.35
DELIVERED PRICE BY SECTOR							
RESIDENTIAL	4.16	7.23	8.22	8.68	8.56	8.75	8.98
COMMERCIAL(4)	3.84	6.99	8.03	8.51	8.42	8.67	8.93
REFINERY	3.08	5.40	6.37	6.79	6.52	6.69	6.75
ELECTRIC UTILITY	2.80	6.34	7.40	7.83	7.46	7.63	7.67
INDUSTRIAL(5)	2.90	6.24	7.28	7.69	7.42	7.61	7.72

(1) INCLUDES INCREASED GAS OR OIL IMPORTS.
(2) REPRESENTS GAS USED AS A FUEL IN FIELD GATHERING AND PLANT PROCESSING MACHINERY.
(3) INDICATES GAS USED TO FUEL COMPRESSORS IN THE PIPELINE MACHINERY.
(4) COMMERCIAL IS AN AGGREGATE OF COMMERCIAL AND OTHER CATEGORIES.
(5) EXCLUDES LEASE AND PLANT FUEL CONSUMPTION.
(6) REPRESENTS IMBALANCES RESULTING FROM THE MERGER OF DATA REPORTING SYSTEMS WHICH VARY IN SCOPE, FORMAT, DEFINITIONS AND TYPE OF RESPONDANTS.

NOTE: ENTRIES FOR 1980 ARE A COMBINATION OF HISTORICAL AND ESTIMATED VALUES.

SOURCES: ON PAGE 222, SEE 1, PP 15-19; 12, PAGE 7, TABLE 1; 13, PAGE 133, TABLE A7.

TABLE C.8.1. COAL SUPPLY AND DISPOSITION
CASE C: HIGH WORLD OIL PRICE
(MILLIONS OF SHORT TONS PER YEAR)

	1980	1985	1986	1987	1988	1989	1990
DOMESTIC SUPPLY							
EASTERN.............	579.	605.	622.	634.	650.	670.	695.
WESTERN.............	251.	311.	322.	334.	349.	367.	391.
NET IMPORTS(1)......	-91.	-108.	-114.	-120.	-127.	-135.	-144.
STOCK WITHDRAWALS...	-36.	0.	0.	0.	0.	0.	0.
TOTAL SUPPLY..........	703.	807.	830.	848.	873.	902.	942.
CONSUMPTION							
RESIDENTIAL/COMM....	7.	7.	7.	7.	7.	6.	6.
INDUSTRIAL..........	60.	76.	80.	84.	88.	93.	97.
METALLURGICAL.......	67.	49.	50.	50.	51.	51.	52.
ELECTRIC UTILITY....	569.	670.	688.	702.	722.	747.	782.
SYNTHETIC USE.......	0.	5.	5.	5.	5.	5.	5.
TOTAL CONSUMPTION.....	703.	807.	830.	848.	873.	902.	942.
TOTAL DISPOSITION.....	703.	807.	830.	848.	873.	902.	942.

(1) EXPORTS TO EUROPE AND JAPAN.

NOTE: EASTERN INCLUDES PENSYLVANIA, OHIO, MARYLAND, WEST VIRGINIA, VIRGINIA, KENTUCKY, TENNESSEE, ALABAMA, ILLINOIS, AND INDIANA. WESTERN INCLUDES IOWA, MISSOURI, KANSAS, ARKANSAS, OKLAHOMA, TEXAS, NORTH DAKOTA, SOUTH DAKOTA, MONTANA, WYOMING, COLORADO, UTAH, ARIZONA, NEW MEXICO, WASHINGTON, AND ALASKA.

NOTE: ENTRIES FOR 1980 ARE HISTORICAL DATA, AND STOCK WITHDRAWALS INCLUDES DISCREPANCY.

Case D
Higher Vehicle Efficiency

In the midprice case, it was assumed that the average fleet efficiency of light duty vehicles improved by 0.40 miles per gallon (mpg) per year. In this study, the fuel efficiency is assumed to increase by 0.48 mpg per year reflecting further improvements in fleet fuel efficiency of 0.08 mpg/year or 6 percent of 1990.

A higher fuel-efficiency would reduce total transportation fuel use. The difference in the fuel-efficiency improvement is projected to reduce gasoline consumption by 1.5 percent in 1985 and 4.1 percent in 1990 (see Table D.1.3). However, the higher efficiency would encourage greater use of light duty vehicles, resulting in a modest rise in total miles travelled (see Table D.4.4).

Assumed Average Light-Vehicle Fuel-Efficiency in Miles Per Gallon

Case	1980	1985	1990
A	14.15	16.68	21.98
D	14.15	17.17	23.29

Case D

THE FOLLOWING SECTION OF TABLES ARE FOR THE:

CASE D: HIGHER VEHICLE EFFICIENCY

THIS SECTION CONTAINS THE FOLLOWING TABLES:

EXECUTIVE SUMMARY TABLES
- TABLE D.1.1. YEARLY SUPPLY AND DISPOSITION OF TOTAL ENERGY
- TABLE D.1.2. SUPPLY/DEMAND BALANCE
- TABLE D.1.3. CONSUMPTION SUMMARY
- TABLE D.1.4. PRICE SUMMARY

END-USE CONSUMPTION TABLES
- TABLE D.4.4. TRANSPORTATION SECTOR ENERGY CONSUMPTION BY MODE

TABLE D.1.1. YEARLY SUPPLY AND DISPOSITION OF TOTAL ENERGY
CASE D: HIGHER VEHICLE EFFICIENCY
(QUADRILLION BTU PER YEAR)

	1975	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
SUPPLY												
PRODUCTION												
PETROLEUM..........	20.1	20.5	20.4	20.6	20.5	20.6	20.4	20.5	20.5	20.5	20.3	19.3
NATURAL GAS........	19.6	20.1	19.9	18.2	17.5	17.0	15.2	14.7	14.8	15.3	15.9	16.4
COAL...............	15.2	19.2	19.1	19.1	19.4	19.4	20.3	20.8	21.3	22.0	22.8	23.8
NUCLEAR............	1.9	2.7	2.9	3.0	3.2	3.7	4.1	4.7	5.3	5.8	6.1	6.3
HYDRO/GEO/OTHER....	3.2	3.0	2.9	3.3	3.2	3.1	3.1	3.1	3.2	3.2	3.2	3.2
SUBTOTAL..........	60.1	65.5	65.2	64.2	63.7	63.8	63.1	63.9	65.0	66.8	68.2	69.1
NET IMPORTS												
CRUDE OIL..........	8.7	10.6	8.8	6.8	7.5	10.3	12.7	12.4	11.6	10.9	10.5	11.3
OTHER PETROLEUM....	3.8	2.9	2.6	2.1	2.5	3.0	3.1	3.1	3.1	3.1	3.1	3.1
NG (CONTRACTED)(1).	0.9	1.0	.9	.9	1.1	1.2	1.2	1.2	1.2	1.2	1.2	1.2
OTHER GAS(2).......	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.2	0.0	0.0	0.0
COAL AND COKE......	-1.7	-2.4	-2.9	-2.8	-2.6	-2.7	-2.9	-3.0	-3.2	-3.4	-3.6	-3.8
ELECTRICITY........	0.1	.2	.2	.2	.2	0.3	0.3	0.3	0.3	0.3	0.4	0.4
SUBTOTAL..........	11.7	12.3	9.6	7.3	8.6	12.1	14.5	14.3	13.3	12.2	11.6	12.2
SPR ADDITIONS(3)....	0.0	-.1	-.7	-.4	-.4	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3
STOCK WITHDRAWALS...	-1.1	-1.8	0.0	-.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL SUPPLY.........	70.7	75.9	74.1	70.9	71.9	75.6	77.4	77.9	78.0	78.7	79.6	81.1
CONSUMPTION												
NON-ELEC UTILITY FUEL												
PETROLEUM..........	29.5	31.5	29.9	28.6	29.2	30.6	31.8	31.5	30.8	30.2	29.8	29.8
NATURAL GAS(4).....	16.7	16.6	16.1	15.0	14.9	14.5	13.7	13.5	13.4	13.7	13.8	14.1
COAL...............	4.0	3.4	3.4	3.0	2.9	3.2	3.3	3.3	3.4	3.5	3.7	3.8
SUBTOTAL..........	50.2	51.4	49.4	46.4	47.0	48.3	48.8	48.3	47.7	47.4	47.3	47.7
ELECTRIC UTILITY FUEL												
PETROLEUM..........	3.2	2.7	2.2	1.8	1.5	2.9	4.1	4.2	4.2	4.1	3.9	3.8
NATURAL GAS........	3.2	3.8	3.8	3.3	3.4	2.7	1.7	1.7	1.7	1.9	2.2	2.5
COAL...............	8.8	12.1	12.7	12.7	13.2	13.5	14.1	14.5	14.7	15.1	15.6	16.3
NUCLEAR............	1.9	2.7	2.9	3.0	3.2	3.7	4.1	4.7	5.3	5.8	6.1	6.3
HYDRO/GEO/OTHER(5).	3.4	3.2	3.1	3.5	3.4	3.4	3.5	3.5	3.5	3.5	3.5	3.4
SUBTOTAL..........	20.5	24.5	24.7	24.3	24.7	25.9	27.2	28.2	29.1	30.1	31.0	32.1
TOTAL CONSUMPTION....	70.7	75.9	74.1	70.7	71.7	74.2	76.0	76.6	76.8	77.5	78.3	79.8
ADJUSTMENTS												
REFINERY LOSSES(6).	0.0	0.0	0.0	0.0	-0.1	0.0	0.2	0.2	0.2	0.3	3.2	0.3
DISCREPANCY(7).....	0.0	0.0	0.0	0.2	0.3	1.4	1.2	1.1	1.0	0.9	1.1	1.0
TOTAL DISPOSITION....	70.7	75.9	74.1	70.9	71.9	75.6	77.4	77.9	78.0	78.7	79.6	81.1

NOTE: THE "ANNUAL ENERGY REVIEW" FOR 1982 WILL CONTAIN LATER REVISIONS TO HISTORICAL DATA FOR 1975, 1980 AND 1982.
NOTE: TOTALS MAY NOT EQUAL SUM OF COMPONENTS DUE TO INDEPENDENT ROUNDING. FOR TABLE FOOTNOTES AND SOURCES SEE PAGE 219.

TABLE D.1.2. SUPPLY/DEMAND BALANCE
CASE D: HIGHER VEHICLE EFFICIENCY
(QUADRILLION BTU PER YEAR)

	1975	1980	1985	1986	1987	1988	1989	1990
DOMESTIC SUPPLY								
COAL	15.2	19.2	20.3	20.8	21.3	22.0	22.8	23.8
NATURAL GAS	19.6	19.9	15.2	14.7	14.8	15.3	15.9	16.4
PETROLEUM	20.1	20.5	20.4	20.5	20.5	20.5	20.3	19.3
NUCLEAR	1.9	2.7	4.1	4.7	5.3	5.8	6.1	6.3
OTHER(1)	3.2	3.0	3.1	3.1	3.2	3.2	3.2	3.2
TOTAL DOMESTIC SUPPLY	60.0	65.3	63.1	63.9	65.0	66.8	68.2	69.1
NATURAL GAS IMPORTS	0.9	1.0	1.2	1.2	1.2	1.2	1.2	1.2
SUPPLEMENTAL GAS(2)	0.0	0.2	0.0	0.3	0.2	0.0	0.0	0.0
PETROLEUM IMPORTS	12.5	13.5	15.8	15.5	14.8	14.0	13.6	14.4
TOTAL SUPPLY(3)	73.4	80.0	80.2	80.9	81.2	82.0	83.1	84.8
DISPOSITION								
RESIDENTIAL	9.6	9.3	9.2	9.2	9.2	9.2	9.2	9.3
COMMERCIAL	5.5	5.9	6.6	6.7	6.8	6.8	6.8	6.9
INDUSTRIAL(4)	21.3	23.0	22.1	22.3	22.4	22.8	23.7	23.9
TRANSPORTATION	17.7	19.7	18.4	18.0	17.4	16.9	16.7	16.5
TOTAL END-USE CONSUMPTION	54.1	57.9	56.4	56.2	55.8	55.8	55.9	56.6
DISCREPANCY	0.2	-0.1	-0.2	-0.1	-0.2	-0.4	-0.3	-0.4
ADJUSTMENTS	19.1	22.2	24.0	24.8	25.6	26.6	27.5	28.6
UTILITY GENERATION	13.7	16.5	18.3	19.0	19.5	20.2	20.8	21.5
UTILITY TRANSMISSION	0.6	0.7	0.9	0.9	0.9	1.0	1.0	1.0
REFINERY(5)	0.0	0.0	0.2	0.2	0.2	0.3	0.2	0.3
GAS PIPELINE(6)	0.6	0.6	1.1	1.0	1.0	1.1	1.1	1.1
LEASE/PLANT FUEL(7)	1.4	1.0	1.1	1.1	1.1	1.2	1.2	1.2
COAL EXPORTS	1.7	2.4	2.9	3.0	3.2	3.4	3.6	3.8
SPR ADDITIONS	0.0	0.1	0.3	0.3	0.3	0.3	0.3	0.3
STOCK WITHDRAWALS	1.1	1.8	0.0	0.0	0.0	0.0	0.0	0.0
RECLASSIFIED	0.0	-0.9	-0.7	-0.7	-0.7	-0.6	-0.6	-0.6
ADJUSTED CONSUMPTION	73.4	80.0	80.2	80.9	81.2	82.0	83.1	84.8
ELECTRIC UTILITY FUEL								
COAL	8.8	12.1	14.1	14.5	14.7	15.1	15.6	16.3
PETROLEUM	3.2	2.7	4.1	4.2	4.2	4.1	3.9	3.8
NATURAL GAS	3.2	3.8	1.7	1.7	1.7	1.9	2.2	2.5
TOTAL FOSSIL	15.2	18.6	20.0	20.4	20.7	21.1	21.7	22.6
NUCLEAR	1.9	2.7	4.1	4.7	5.3	5.8	6.1	6.3
OTHER	3.2	3.0	3.1	3.1	3.2	3.2	3.2	3.2
TOTAL	20.3	24.3	[illegible]	28.2	29.1	30.1	31.0	32.1
GENERATION	6.6	7.8	8.9	9.3	9.6	9.9	10.2	10.6

NOTE: TOTALS MAY NOT EQUAL SUM OF COMPONENTS DUE TO INDEPENDENT ROUNDING. FOR TABLE FOOTNOTES AND SOURCES SEE PAGE 219.

TABLE D.1.3. CONSUMPTION SUMMARY
CASE D: HIGHER VEHICLE EFFICIENCY
(QUADRILLION BTU PER YEAR)

	1975	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
RESIDENTIAL	9.571	9.335	9.104	9.236	9.143	9.173	9.206	9.228	9.232	9.233	9.243	9.262
STEAM COAL	0.091	0.065	0.080	0.082	0.071	0.078	0.076	0.074	0.073	0.071	0.069	0.068
NATURAL GAS	5.022	4.866	4.654	4.793	4.710	4.649	4.585	4.521	4.463	4.413	4.374	4.343
DISTILLATE(1)	1.923	1.417	1.375	1.303	1.230	1.308	1.327	1.335	1.330	1.317	1.300	1.284
LIQUID PETROLEUM GAS	0.528	0.539	0.536	0.570	0.590	0.564	0.575	0.581	0.580	0.576	0.572	0.568
ELECTRICITY	2.007	2.448	2.459	2.488	2.530	2.574	2.642	2.716	2.787	2.856	2.928	3.000
COMMERCIAL	5.513	5.892	5.818	5.866	6.182	6.443	6.608	6.715	6.766	6.783	6.823	6.871
STEAM COAL	0.135	0.095	0.107	0.122	0.086	0.097	0.095	0.092	0.090	0.087	0.085	0.082
NATURAL GAS	2.559	2.674	2.580	2.683	2.720	2.731	2.723	2.692	2.643	2.587	2.541	2.498
DISTILLATE(1)	0.622	0.556	0.540	0.511	0.670	0.741	0.778	0.805	0.819	0.824	0.829	0.832
LO-SULFUR RESIDUAL	0.506	0.566	0.470	0.376	0.490	0.544	0.571	0.591	0.601	0.605	0.609	0.611
LIQUID PETROLEUM GAS	0.093	0.095	0.095	0.101	0.090	0.080	0.078	0.076	0.074	0.072	0.070	0.068
ELECTRICITY	1.598	1.906	2.026	2.074	2.150	2.251	2.362	2.459	2.539	2.607	2.690	2.780
INDUSTRIAL(2)	18.503	20.184	19.512	16.876	17.365	18.888	19.585	19.806	19.971	20.448	20.867	21.598
STEAM COAL	1.619	1.388	1.570	1.626	1.501	1.770	1.801	1.854	1.934	2.038	2.148	2.253
METALLURGICAL COAL	2.178	1.793	1.647	1.057	1.132	1.262	1.302	1.324	1.336	1.352	1.358	1.373
NATURAL GAS	6.133	6.497	6.639	5.414	5.340	5.338	4.907	4.822	4.884	5.150	5.325	5.586
DISTILLATE	1.272	1.569	1.285	1.212	1.340	1.747	2.221	2.244	2.136	2.022	1.950	1.930
LO-SULFUR RESIDUAL	0.428	0.554	0.423	0.367	0.390	0.483	0.547	0.554	0.546	0.541	0.538	0.552
HI-SULFUR RESIDUAL	0.856	0.713	0.532	0.484	0.530	0.702	0.834	0.849	0.837	0.822	0.815	0.831
LIQUID PETROLEUM GAS	0.252	0.308	0.323	0.332	0.370	0.366	0.382	0.357	0.312	0.264	0.218	0.181
PET-CHEM FEEDSTOCK(3)	1.519	2.401	2.111	1.862	1.980	2.172	2.286	2.365	2.443	2.548	2.661	2.822
OTHER(4)	1.900	2.180	2.166	1.977	2.240	2.207	2.258	2.253	2.240	2.239	2.257	2.287
ELECTRICITY	2.346	2.781	2.817	2.545	2.620	2.843	3.047	3.183	3.302	3.473	3.598	3.781
TRANSPORTATION(5)	17.725	19.114	18.715	18.129	17.910	18.413	18.422	17.950	17.416	16.942	16.669	16.529
DISTILLATE	2.069	2.782	2.738	2.582	2.510	2.780	2.890	2.962	3.036	3.108	3.198	3.309
HI-SULFUR RESIDUAL	0.731	1.401	1.163	0.930	0.900	1.011	1.053	1.077	1.100	1.119	1.145	1.178
GASOLINE(6)	12.868	12.712	12.688	12.528	12.180	12.348	12.108	11.481	10.806	10.206	9.770	9.431
JET FUEL(7)	2.029	2.179	2.087	2.049	2.280	2.233	2.331	2.390	2.434	2.468	2.516	2.572
LIQUID PETROLEUM GAS	0.016	0.014	0.014	0.015	0.020	0.015	0.015	0.015	0.015	0.015	0.015	0.015
OTHER	0.000	0.014	0.014	0.014	0.010	0.014	0.014	0.014	0.014	0.014	0.014	0.014
ELECTRICITY	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010
ELECTRIC UTILITY FUEL	20.360	24.243	24.462	24.203	24.480	25.943	27.225	28.239	29.080	30.097	30.996	32.121
STEAM COAL	8.790	12.122	12.707	12.697	13.190	13.538	14.147	14.482	14.748	15.121	15.595	16.267
NATURAL GAS	3.240	3.807	3.764	3.336	3.440	2.707	1.698	1.714	1.744	1.884	2.236	2.473
DISTILLATE(8)	0.350	0.121	0.077	0.048	0.090	0.181	0.346	0.373	0.322	0.334	0.372	0.458
LO-SULFUR RESIDUAL(9)	2.860	1.611	1.251	0.980	0.780	1.784	2.598	2.646	2.657	2.605	2.306	2.179
HI-SULFUR RESIDUAL	NA	0.922	0.898	0.789	0.600	0.946	1.184	1.198	1.204	1.204	1.189	1.202
HYDRO/GEO/OTHER(10)	3.220	2.988	2.864	3.340	3.190	3.115	3.133	3.149	3.153	3.168	3.185	3.211
NUCLEAR	1.900	2.672	2.901	3.013	3.190	3.671	4.118	4.678	5.253	5.782	6.114	6.331
REFINERY FUEL(11)	2.769	2.787	2.304	2.190	2.480	2.345	2.545	2.526	2.465	2.481	2.344	2.329
NATURAL GAS	0.975	0.846	0.668	0.574	0.720	0.438	0.300	0.281	0.289	0.326	0.346	0.376
DISTILLATE	0.035	0.018	0.011	0.011	0.010	0.012	0.013	0.013	0.012	0.012	0.012	0.012
LO-SULFUR RESIDUAL	NA	NA	NA	NA	0.090	0.117	0.149	0.149	0.140	0.128	0.120	0.115
HI-SULFUR RESIDUAL	0.269	0.213	0.167	0.137	0.200	0.292	0.469	0.482	0.460	0.412	0.380	0.349
LIQUID PETROLEUM GAS	0.050	0.043	0.024	0.038	0.030	0.025	0.028	0.027	0.027	0.026	0.025	0.025
OTHER(12)	0.390	0.436	0.359	0.348	0.360	0.364	0.395	0.392	0.382	0.372	0.364	0.361
STILL GAS	1.050	1.231	1.073	1.085	1.080	1.098	1.191	1.183	1.154	1.124	1.097	1.090

NOTE: TOTALS MAY NOT EQUAL SUM OF COMPONENTS DUE TO INDEPENDENT ROUNDING. FOR TABLE FOOTNOTES AND SOURCES SEE PAGE 219.

TABLE D.1.4. PRICE SUMMARY
CASE D: HIGHER VEHICLE EFFICIENCY
(1982 DOLLARS PER MILLION BTU)

	1975	1980	1985	1986	1987	1988	1989	1990
WORLD OIL PRICE.........	20.70	39.32	25.47	28.24	31.53	34.11	35.68	36.71
RESIDENTIAL	5.95	8.33	9.53	10.28	10.95	11.31	11.53	11.77
NATURAL GAS...........	2.75	4.16	6.65	7.44	8.03	8.28	8.38	8.56
DISTILLATE(1).........	4.75	8.59	6.29	6.95	7.75	8.39	8.78	9.06
LIQUID PETROLEUM GAS..	4.11	6.67	6.07	6.72	7.43	7.97	8.29	8.58
ELECTRICITY	15.61	16.78	17.12	17.62	18.11	18.24	18.29	18.39
COMMERCIAL	6.27	8.38	10.07	10.83	11.52	11.92	12.19	12.47
NATURAL GAS...........	2.17	3.84	6.42	7.25	7.87	8.14	8.30	8.50
DISTILLATE(1).........	4.30	8.06	5.95	6.59	7.34	7.95	8.32	8.58
LO-SULFUR RESIDUAL....	4.13	5.32	4.81	5.34	5.96	6.49	6.82	7.13
LIQUID PETROLEUM GAS..	NA	6.67	6.09	6.74	7.45	7.99	8.31	8.60
ELECTRICITY	15.55	17.21	17.36	17.91	18.43	18.60	18.68	18.77
INDUSTRIAL(2)	3.37	5.44	6.45	7.03	7.59	7.92	8.12	8.30
STEAM COAL............	1.81	1.55	2.10	2.13	2.16	2.20	2.25	2.33
METALLURGICAL COAL....	2.80	2.51	2.56	2.59	2.61	2.63	2.66	2.72
NATURAL GAS...........	1.49	2.90	5.62	6.46	7.02	7.13	7.20	7.25
DISTILLATE............	4.24	7.99	5.86	6.49	7.24	7.84	8.21	8.47
LO-SULFUR RESIDUAL....	4.11	5.14	4.73	5.25	5.86	6.38	6.79	7.01
HI-SULFUR RESIDUAL....	2.93	NA	4.21	4.75	5.38	5.91	6.25	6.56
LIQUID PETROLEUM GAS..	3.83	6.34	5.87	6.49	7.17	7.69	8.00	8.28
PET-CHEM FEEDSTOCK(3).	NA	7.88	6.74	7.43	8.28	8.96	9.38	9.67
OTHER(4)..............	NA	NA	5.20	5.73	6.38	6.91	7.25	7.49
ELECTRICITY	9.42	11.67	14.16	14.60	15.05	15.18	15.25	15.38
TRANSPORTATION(5)	6.72	9.91	7.73	8.40	9.17	9.72	10.01	10.14
DISTILLATE............	5.85	8.39	6.22	6.89	7.69	8.32	8.72	8.99
HI-SULFUR RESIDUAL....	2.93	3.97	3.67	4.16	4.73	5.21	5.51	5.81
GASOLINE(6)...........	7.57	11.32	8.67	9.43	10.30	10.90	11.20	11.31
JET FUEL(7)...........	3.69	7.51	6.60	7.25	8.06	8.70	9.09	9.36
LIQUID PETROLEUM GAS..	NA	NA	5.81	6.44	7.13	7.65	7.97	8.25
ELECTRICITY	NA	NA	16.73	17.29	17.82	18.02	18.12	18.19
ELECTRIC UTILITY FUEL	2.04	1.84	2.07	2.20	2.30	2.36	2.41	2.48
STEAM COAL............	1.58	1.71	1.74	1.75	1.77	1.79	1.81	1.86
NATURAL GAS...........	1.14	2.80	5.53	6.45	7.02	7.03	7.18	7.25
DISTILLATE(8).........	3.28	7.22	5.88	6.52	7.27	7.87	8.24	8.50
LO-SULFUR RESIDUAL(9).	3.27	5.90	4.80	5.34	5.97	6.49	6.72	6.96
HI-SULFUR RESIDUAL....	NA	4.55	3.69	4.18	4.74	5.22	5.52	5.81
NUCLEAR...............	NA	.85	0.85	0.85	0.85	0.85	0.85	0.85
REFINERY FUEL	NA	NA	2.32	2.60	2.93	3.17	3.31	3.42
NATURAL GAS...........	NA	3.08	4.74	5.51	6.08	6.21	6.27	6.28
DISTILLATE............	NA	6.09	5.15	5.72	6.39	6.93	7.27	7.50
LO-SULFUR RESIDUAL....	NA	NA	4.15	4.62	5.10	5.65	5.94	6.23
HI-SULFUR RESIDUAL....	NA	4.89	3.49	3.97	4.52	4.99	5.29	5.58
LIQUID PETROLEUM GAS..	NA	NA	5.17	5.74	6.36	6.83	7.12	7.38
OTHER(10).............	NA	NA	5.09	5.62	6.27	6.80	7.14	7.38

NOTE: TOTALS MAY NOT EQUAL SUM OF COMPONENTS DUE TO INDEPENDENT ROUNDING. FOR TABLE FOOTNOTES AND SOURCES SEE PAGE 219.

TABLE D.4.4. TRANSPORTATION SECTOR ENERGY CONSUMPTION BY MODE
CASE D: HIGHER VEHICLE EFFICIENCY

	1980	1985	1986	1987	1988	1989	1990
FUEL CONSUMPTION, ALL MODES							
GASOLINE(1)	12.712	12.108	11.481	10.806	10.206	9.770	9.431
DISTILLATE(1)	2.782	2.890	2.962	3.036	3.108	3.198	3.309
JET FUEL(1)	2.179	2.331	2.390	2.434	2.468	2.516	2.572
RESIDUAL(1)	1.401	1.053	1.077	1.100	1.119	1.145	1.178
LIQUID GAS(1)	0.014	0.015	0.015	0.015	0.015	0.015	0.015
FUEL USE IN LIGHT DUTY VEHICLES							
SALES:LIGHT DUTY VEHICLES(3)	10.750	13.254	13.644	14.123	14.702	15.081	15.004
VEHICLE-MILES:TOTAL(2)	1384.	1614.	1642.	1661.	1679.	1710.	1746.
FLEET-MILES PER GALLON:TOTAL	14.15	17.17	18.38	19.68	20.97	22.17	23.29
PERCENT FLEET VMT DIESEL	0.010	0.021	0.025	0.032	0.039	0.046	0.054
VEHICLE-MILES:GAS(2)	1370.	1581.	1600.	1609.	1615.	1631.	1651.
FLEET-MILES PER GALLON:GAS	13.94	16.97	18.12	19.36	20.57	21.70	22.75
FUEL USE:GAS(4)	98.218	93.133	88.297	83.084	78.484	75.172	72.556
VEHICLE-MILES:DIESEL(2)	14.	33.	42.	52.	65.	79.	95.
FLEET-MILES PER GALLON:DIESEL	25.30	27.29	28.41	29.61	30.70	31.65	32.50
FUEL USE:DIESEL(4)	0.563	1.218	1.470	1.768	2.106	2.494	2.922
FUEL USE IN HEAVY TRUCKS							
SALES:HEAVY TRUCKS(3)	0.487	0.644	0.675	0.706	0.736	0.756	0.734
VEHICLE-MILES:TOTAL(2)	105.	124.	128.	131.	134.	137.	141.
FLEET-MILES PER GALLON:TOTAL	5.82	6.85	7.07	7.29	7.52	7.75	7.96
PERCENT FLEET VMT DIESEL	0.591	0.656	0.669	0.683	0.697	0.710	0.722
VEHICLE-MILES:GAS(2)	43.	43.	42.	41.	40.	40.	39.
FLEET-MILES PER GALLON:GAS	6.84	8.29	8.60	8.92	9.25	9.56	9.78
FUEL USE:GAS(4)	6.256	5.169	4.912	4.649	4.379	4.149	4.009
VEHICLE-MILES:DIESEL(2)	62.	82.	85.	89.	93.	97.	102.
FLEET-MILES PER GALLON:DIESEL	5.09	6.09	6.31	6.54	6.77	7.01	7.23
FUEL USE:DIESEL(4)	12.147	13.393	13.538	13.655	13.733	13.877	14.106
FUEL USE IN AIR							
REVENUE PASSENGER-MILES(3)	265.	343.	361.	374.	384.	397.	413.
AVERAGE FLIGHT SIZE	158.	167.	170.	172.	174.	176.	178.
LOAD FACTOR	0.62	0.64	0.64	0.65	0.65	0.66	0.66
FUEL BURNED PER SEAT-MILE(5)	0.023	0.022	0.021	0.021	0.021	0.020	0.020
TOTAL JET FUEL(4)	16.529	19.019	19.506	19.860	20.140	20.531	20.989
FUEL USE IN OTHER							
NON-HWY DSL(1)	4.436	4.696	4.777	4.856	4.922	4.991	5.072
RESIDUAL(1)	1.545	1.793	1.834	1.872	1.906	1.950	2.005

(1) QUADRILLION BTU PER YEAR.
(2) BILLIONS PER YEAR.
(3) MILLIONS PER YEAR.
(4) BILLIONS OF GALLONS PER YEAR.
(5) GALLONS PER YEAR.
NOTE: ENTRIES FOR 1980 ARE A COMBINATION OF HISTORICAL AND ESTIMATED VALUES.

Case E
High Utilization of Existing Powerplants

Due to forced outages, schedule maintenance, or insufficient demand, electric powerplants do not operate around-the-clock. Typically, a "baseload" plant generates electricity about 60 to 65 percent of the time. This study assumes a 2 percent increase in the utilization rate of existing steam and nuclear plants over the base assumption of 62 percent (based upon average usage in 1980 and 1981).

A higher utilization rate would enable utilities to produce more electricity using their more economical units, particularly coal-fired and nuclear plants. Projected utility coal consumption would increase by about 1 percent in 1985 and 2 percent in 1990. Similarly, fuel inputs to nuclear plants would rise by 5 percent in 1985 and 3 percent in 1990.

The increased use of the more economical coal and nuclear capacity would also lower prices and increase the electricity demand slightly. The additional output from the existing coal and nuclear plants would exceed the incremental electricity demand reduction, resulting in the displacement of some existing oil and natural gas capacity. Consequently, the combined utility oil and gas consumption would be about 3.5 percent lower in 1985 and 4.7 percent less in 1990.

THE FOLLOWING SECTION OF TABLES ARE FOR THE:

CASE E: HIGH UTILIZATION OF EXISTING POWERPLANTS

THIS SECTION CONTAINS THE FOLLOWING TABLES:

EXECUTIVE SUMMARY TABLES
  TABLE E.1.1. YEARLY SUPPLY AND DISPOSITION OF TOTAL ENERGY
  TABLE E.1.2. SUPPLY/DEMAND BALANCE
  TABLE E.1.3. CONSUMPTION SUMMARY
  TABLE E.1.4. PRICE SUMMARY

ELECTRIC UTILITY TABLES
  TABLE E.5.1. ELECTRIC UTILITY FUEL PRICES AND CONSUMPTION
  TABLE E.5.2. END-USE ELECTRICITY PRICES AND CONSUMPTION

TABLE E.1.1. YEARLY SUPPLY AND DISPOSITION OF TOTAL ENERGY
CASE E: HIGH UTILIZATION OF EXISTING POWERPLANTS
(QUADRILLION BTU PER YEAR)

	1975	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
SUPPLY												
PRODUCTION												
PETROLEUM..........	20.1	20.5	20.4	20.6	20.5	20.6	20.5	20.5	20.5	20.5	20.3	19.3
NATURAL GAS........	19.6	20.1	19.9	18.2	17.5	17.0	15.1	14.6	14.7	15.3	15.8	16.3
COAL...............	15.2	19.2	19.1	19.1	19.4	19.6	20.4	21.0	21.6	22.3	23.1	24.2
NUCLEAR............	1.9	2.7	2.9	3.0	3.2	3.8	4.3	4.9	5.5	6.0	6.3	6.5
HYDRO/GEO/OTHER....	3.2	3.0	2.9	3.3	3.2	3.0	3.1	3.0	3.0	3.0	3.0	3.1
SUBTOTAL.........	60.1	65.5	65.2	64.2	63.7	64.0	63.4	64.1	65.3	67.1	68.5	69.4
NET IMPORTS												
CRUDE OIL..........	8.7	10.6	8.8	6.8	7.5	10.4	12.9	12.6	11.9	11.3	10.9	11.8
OTHER PETROLEUM....	3.8	2.9	2.6	2.1	2.5	2.9	3.0	3.1	3.1	3.1	3.1	3.1
NG (CONTRACTED)(1).	0.9	1.0	.9	.9	1.1	1.2	1.2	1.2	1.2	1.2	1.2	1.2
OTHER GAS(2).......	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.2	0.0	0.0	0.0
COAL AND COKE......	-1.7	-2.4	-2.9	-2.8	-2.6	-2.7	-2.9	-3.0	-3.2	-3.4	-3.6	-3.8
ELECTRICITY........	0.1	.2	.2	.2	.2	0.3	0.3	0.3	0.3	0.3	0.4	0.4
SUBTOTAL.........	11.7	12.3	9.6	7.3	8.6	12.2	14.6	14.5	13.6	12.6	12.0	12.7
SPR ADDITIONS(3)....	0.0	-.1	-.7	-.4	-.4	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3
STOCK WITHDRAWALS...	-1.1	-1.8	0.0	-.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL SUPPLY.........	70.7	75.9	74.1	70.9	71.9	75.8	77.7	78.3	78.5	79.3	80.2	81.8
CONSUMPTION												
NON-ELEC UTILITY FUEL												
PETROLEUM..........	29.5	31.5	29.9	28.6	29.2	30.7	32.0	31.8	31.2	30.6	30.3	30.3
NATURAL GAS(4).....	16.7	16.6	16.1	15.0	14.9	14.5	13.7	13.5	13.5	13.7	13.9	14.1
COAL...............	4.0	3.4	3.4	3.0	2.9	3.2	3.3	3.3	3.4	3.5	3.6	3.8
SUBTOTAL.........	50.2	51.4	49.4	46.4	47.0	48.4	49.0	48.6	48.0	47.8	47.8	48.2
ELECTRIC UTILITY FUEL												
PETROLEUM..........	3.2	2.7	2.2	1.8	1.5	2.9	4.0	4.1	4.1	4.1	3.8	3.8
NATURAL GAS........	3.2	3.8	3.8	3.3	3.4	2.7	1.6	1.6	1.7	1.8	2.1	2.3
COAL...............	8.8	12.1	12.7	12.7	13.2	13.7	14.3	14.7	15.0	15.4	15.9	16.6
NUCLEAR............	1.9	2.7	2.9	3.0	3.2	3.8	4.3	4.9	5.5	6.0	6.3	6.5
HYDRO/GEO/OTHER(5).	3.4	3.2	3.1	3.5	3.4	3.3	3.4	3.4	3.4	3.4	3.4	3.4
SUBTOTAL.........	20.5	24.5	24.7	24.3	24.7	26.0	27.3	28.3	29.2	30.3	31.2	32.4
TOTAL CONSUMPTION....	70.7	75.9	74.1	70.7	71.7	74.4	76.3	77.0	77.3	78.1	79.0	80.6
ADJUSTMENTS												
REFINERY LOSSES(6).	0.0	0.0	0.0	0.0	-0.1	0.0	0.2	0.2	0.2	0.2	0.2	0.2
DISCREPANCY(7).....	0.0	0.0	0.0	0.2	0.3	1.4	1.2	1.1	1.0	1.0	1.0	1.0
TOTAL DISPOSITION....	70.7	75.9	74.1	70.9	71.9	75.8	77.7	78.3	78.5	79.3	80.2	81.8

NOTE: THE "ANNUAL ENERGY REVIEW" FOR 1982 WILL CONTAIN LATER REVISIONS TO HISTORICAL DATA FOR 1975, 1980 AND 1982.
NOTE: TOTALS MAY NOT EQUAL SUM OF COMPONENTS DUE TO INDEPENDENT ROUNDING. FOR TABLE FOOTNOTES AND SOURCES SEE PAGE 219.

TABLE E.1.2. SUPPLY/DEMAND BALANCE
CASE E: HIGH UTILIZATION OF EXISTING POWERPLANTS
(QUADRILLION BTU PER YEAR)

	1975	1980	1985	1986	1987	1988	1989	1990
DOMESTIC SUPPLY								
COAL	15.2	19.2	20.4	21.0	21.6	22.3	23.1	24.2
NATURAL GAS	19.6	19.9	15.1	14.6	14.7	15.3	15.8	16.3
PETROLEUM	20.1	20.5	20.5	20.5	20.5	20.5	20.3	19.3
NUCLEAR	1.9	2.7	4.3	4.9	5.5	6.0	6.3	6.5
OTHER(1)	3.2	3.0	3.1	3.0	3.0	3.0	3.0	3.1
TOTAL DOMESTIC SUPPLY	60.0	65.3	63.4	64.1	65.3	67.1	68.5	69.4
NATURAL GAS IMPORTS	0.9	1.0	1.2	1.2	1.2	1.2	1.2	1.2
SUPPLEMENTAL GAS(2)	0.0	0.2	0.0	0.3	0.2	0.0	0.0	0.0
PETROLEUM IMPORTS	12.5	13.5	15.9	15.7	15.0	14.3	14.0	14.9
TOTAL SUPPLY(3)	73.4	80.0	80.5	81.3	81.7	82.6	83.8	85.6
DISPOSITION								
RESIDENTIAL	9.6	9.3	9.2	9.2	9.2	9.2	9.3	9.3
COMMERCIAL	5.5	5.9	6.6	6.7	6.8	6.8	6.8	6.9
INDUSTRIAL(4)	21.3	23.0	22.2	22.4	22.5	23.0	23.4	24.1
TRANSPORTATION	17.7	19.7	18.6	18.2	17.7	17.3	17.0	16.9
TOTAL END-USE CONSUMPTION	54.1	57.9	56.6	56.5	56.2	56.3	56.5	57.2
DISCREPANCY	0.2	-0.1	-0.2	-0.1	-0.2	-0.4	-0.4	-0.4
ADJUSTMENTS	19.1	22.2	24.1	24.9	25.7	26.7	27.7	28.8
UTILITY GENERATION	13.7	16.5	18.4	19.0	19.6	20.3	20.9	21.7
UTILITY TRANSMISSION	0.6	0.7	0.9	0.9	0.9	1.0	1.0	1.0
REFINERY(5)	0.0	0.0	0.2	0.2	0.2	0.2	0.2	0.2
GAS PIPELINE(6)	0.6	0.6	1.1	1.0	1.0	1.1	1.1	1.1
LEASE/PLANT FUEL(7)	1.4	1.0	1.1	1.1	1.1	1.1	1.2	1.2
COAL EXPORTS	1.7	2.4	2.9	3.0	3.2	3.4	3.6	3.8
SPR ADDITIONS	0.0	0.1	0.3	0.3	0.3	0.3	0.3	0.3
STOCK WITHDRAWALS	1.1	1.8	0.0	0.0	0.0	0.0	0.0	0.0
RECLASSIFIED	0.0	-0.9	-0.7	-0.7	-0.7	-0.6	-0.6	-0.6
ADJUSTED CONSUMPTION	73.4	80.0	80.5	81.3	81.7	82.6	83.8	85.6
ELECTRIC UTILITY FUEL								
COAL	8.8	12.1	14.3	14.7	15.0	15.4	15.9	16.6
PETROLEUM	3.2	2.7	4.0	4.1	4.1	4.1	3.8	3.8
NATURAL GAS	3.2	3.8	1.6	1.6	1.7	1.8	2.1	2.3
TOTAL FOSSIL	15.2	18.6	20.0	20.4	20.7	21.3	21.8	22.8
NUCLEAR	1.9	2.7	4.3	4.9	5.5	6.0	6.3	6.5
OTHER	3.2	3.0	3.1	3.0	3.0	3.0	3.0	3.1
TOTAL	20.3	24.3	27.3	28.3	29.2	30.3	31.2	32.4
GENERATION	6.6	7.8	9.0	9.3	9.6	10.0	10.5	10.7

NOTE: TOTALS MAY NOT EQUAL SUM OF COMPONENTS DUE TO INDEPENDENT ROUNDING. FOR TABLE FOOTNOTES AND SOURCES SEE PAGE 219.

TABLE E.1.3. CONSUMPTION SUMMARY
CASE E: HIGH UTILIZATION OF EXISTING POWERPLANTS
(QUADRILLION BTU PER YEAR)

	1975	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
RESIDENTIAL	9.571	9.335	9.104	9.236	9.143	9.173	9.208	9.233	9.239	9.242	9.255	9.275
STEAM COAL	0.091	0.065	0.080	0.082	0.071	0.078	0.076	0.074	0.073	0.071	0.069	0.068
NATURAL GAS	5.022	4.866	4.654	4.793	4.710	4.650	4.587	4.524	4.465	4.415	4.377	4.346
DISTILLATE(1)	1.923	1.417	1.375	1.303	1.230	1.308	1.328	1.336	1.332	1.318	1.302	1.286
LIQUID PETROLEUM GAS	0.528	0.539	0.536	0.570	0.590	0.565	0.576	0.582	0.582	0.578	0.574	0.570
ELECTRICITY	2.007	2.448	2.459	2.488	2.530	2.572	2.641	2.717	2.788	2.859	2.932	3.005
COMMERCIAL	5.513	5.892	5.818	5.866	6.182	6.436	6.601	6.709	6.760	6.778	6.819	6.867
STEAM COAL	0.135	0.095	0.107	0.122	0.086	0.097	0.095	0.092	0.090	0.087	0.085	0.083
NATURAL GAS	2.559	2.674	2.580	2.683	2.720	2.731	2.724	2.694	2.646	2.590	2.544	2.502
DISTILLATE(1)	0.622	0.556	0.540	0.511	0.670	0.738	0.775	0.801	0.815	0.820	0.825	0.828
LO-SULFUR RESIDUAL	0.506	0.566	0.470	0.376	0.490	0.542	0.569	0.588	0.598	0.602	0.606	0.608
LIQUID PETROLEUM GAS	0.093	0.095	0.095	0.101	0.090	0.080	0.078	0.076	0.074	0.072	0.070	0.068
ELECTRICITY	1.598	1.906	2.026	2.074	2.150	2.249	2.360	2.457	2.537	2.606	2.690	2.779
INDUSTRIAL(2)	18.503	20.185	19.513	16.876	17.365	18.921	19.637	19.865	20.043	20.534	20.973	21.732
STEAM COAL	1.619	1.388	1.570	1.626	1.501	1.769	1.798	1.846	1.924	2.026	2.134	2.241
METALLURGICAL COAL	2.178	1.793	1.647	1.057	1.132	1.262	1.302	1.324	1.336	1.352	1.359	1.374
NATURAL GAS	6.133	6.497	6.639	5.414	5.340	5.348	4.934	4.837	4.903	5.171	5.360	5.629
DISTILLATE	1.272	1.569	1.285	1.212	1.340	1.741	2.208	2.242	2.136	2.025	1.952	1.936
LO-SULFUR RESIDUAL	0.428	0.554	0.423	0.368	0.390	0.484	0.548	0.557	0.550	0.545	0.542	0.558
HI-SULFUR RESIDUAL	0.856	0.713	0.531	0.483	0.530	0.702	0.833	0.852	0.841	0.827	0.821	0.840
LIQUID PETROLEUM GAS	0.252	0.308	0.323	0.332	0.370	0.365	0.381	0.357	0.312	0.265	0.219	0.182
PET-CHEM FEEDSTOCK(3)	1.519	2.401	2.111	1.862	1.980	2.177	2.294	2.374	2.453	2.560	2.675	2.839
OTHER(4)	1.900	2.180	2.166	1.977	2.240	2.207	2.259	2.253	2.241	2.239	2.258	2.288
ELECTRICITY	2.346	2.781	2.817	2.545	2.620	2.867	3.081	3.222	3.347	3.522	3.653	3.846
TRANSPORTATION(5)	17.725	19.655	18.715	18.129	17.910	18.541	18.610	18.190	17.700	17.267	17.037	16.941
DISTILLATE	2.069	2.782	2.738	2.582	2.510	2.781	2.892	2.964	3.039	3.111	3.201	3.312
HI-SULFUR RESIDUAL	0.731	1.401	1.163	0.930	0.900	1.013	1.055	1.079	1.102	1.122	1.149	1.182
GASOLINE(6)	12.868	13.253	12.688	12.528	12.180	12.473	12.291	11.714	11.084	10.524	10.129	9.832
JET FUEL(7)	2.029	2.179	2.087	2.049	2.280	2.234	2.332	2.392	2.435	2.470	2.518	2.574
LIQUID PETROLEUM GAS	0.016	0.014	0.014	0.015	0.020	0.015	0.015	0.015	0.015	0.015	0.015	0.015
OTHER	0.000	0.014	0.014	0.014	0.010	0.014	0.014	0.014	0.014	0.014	0.014	0.014
ELECTRICITY	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010
ELECTRIC UTILITY FUEL	20.360	24.243	24.462	24.203	24.480	25.999	27.313	28.338	29.229	30.272	31.198	32.375
STEAM COAL	8.790	12.122	12.707	12.697	13.190	13.687	14.307	14.691	14.962	15.386	15.884	16.597
NATURAL GAS	3.240	3.807	3.764	3.336	3.440	2.671	1.625	1.635	1.679	1.800	2.129	2.334
DISTILLATE(8)	0.350	0.121	0.077	0.048	0.090	0.159	0.307	0.310	0.265	0.279	0.318	0.403
LO-SULFUR RESIDUAL(9)	2.860	1.611	1.251	0.980	0.780	1.775	2.583	2.639	2.655	2.616	2.343	2.255
HI-SULFUR RESIDUAL	NA	0.922	0.898	0.789	0.600	0.918	1.153	1.172	1.177	1.181	1.163	1.179
HYDRO/GEO/OTHER(10)	3.220	2.988	2.864	3.340	3.190	3.003	3.064	3.036	3.039	3.022	3.037	3.052
NUCLEAR	1.900	2.672	2.901	3.013	3.190	3.785	4.275	4.855	5.451	5.988	6.333	6.545
REFINERY FUEL(11)	2.769	2.787	2.304	2.190	2.480	2.355	2.559	2.546	2.489	2.431	2.389	2.373
NATURAL GAS	0.975	0.846	0.668	0.574	0.720	0.439	0.304	0.281	0.290	0.327	0.350	0.381
DISTILLATE	0.035	0.018	0.011	0.011	0.010	0.012	0.013	0.013	0.012	0.012	0.012	0.012
LO-SULFUR RESIDUAL	NA	NA	NA	NA	0.090	0.118	0.149	0.151	0.142	0.130	0.122	0.118
HI-SULFUR RESIDUAL	0.269	0.213	0.167	0.137	0.200	0.293	0.470	0.487	0.466	0.420	0.387	0.358
LIQUID PETROLEUM GAS	0.050	0.043	0.024	0.038	0.030	0.026	0.028	0.028	0.027	0.026	0.026	0.026
OTHER(12)	0.390	0.436	0.359	0.348	0.360	0.365	0.397	0.395	0.386	0.377	0.369	0.368
STILL GAS	1.050	1.231	1.073	1.085	1.080	1.102	1.198	1.192	1.165	1.138	1.114	1.111

NOTE: TOTALS MAY NOT EQUAL SUM OF COMPONENTS DUE TO INDEPENDENT ROUNDING. FOR TABLE FOOTNOTES AND SOURCES SEE PAGE 219.

TABLE E.1.4. PRICE SUMMARY
CASE E: HIGH UTILIZATION OF EXISTING POWERPLANTS
(1982 DOLLARS PER MILLION BTU)

	1975	1980	1985	1986	1987	1988	1989	1990
WORLD OIL PRICE.........	20.70	39.32	25.47	28.24	31.53	34.11	35.68	36.71
RESIDENTIAL	5.95	8.33	9.47	10.23	10.88	11.24	11.45	11.69
NATURAL GAS...........	2.75	4.16	6.61	7.42	8.00	8.25	8.33	8.52
DISTILLATE(1).........	4.75	8.59	6.27	6.93	7.72	8.35	8.75	9.02
LIQUID PETROLEUM GAS..	4.11	6.67	6.03	6.67	7.36	7.89	8.20	8.48
ELECTRICITY	15.61	16.78	17.01	17.51	17.97	18.09	18.14	18.24
COMMERCIAL	6.27	8.30	10.01	10.78	11.45	11.84	12.10	12.40
NATURAL GAS...........	2.17	3.84	6.37	7.23	7.84	8.11	8.25	8.46
DISTILLATE(1).........	4.30	8.06	5.93	6.56	7.31	7.91	8.29	8.54
LO-SULFUR RESIDUAL....	4.13	5.32	4.78	5.31	5.92	6.43	6.75	7.06
LIQUID PETROLEUM GAS..	NA	6.67	6.04	6.68	7.38	7.91	8.22	8.50
ELECTRICITY	15.55	17.21	17.26	17.79	18.29	18.46	18.53	18.64
INDUSTRIAL(2)	3.37	5.44	6.43	7.02	7.57	7.90	8.09	8.27
STEAM COAL............	1.81	1.55	2.10	2.13	2.16	2.20	2.25	2.34
METALLURGICAL COAL....	2.80	2.51	2.57	2.59	2.61	2.64	2.67	2.72
NATURAL GAS...........	1.49	2.90	5.57	6.44	6.99	7.10	7.16	7.21
DISTILLATE............	4.24	7.99	5.84	6.47	7.21	7.81	8.18	8.43
LO-SULFUR RESIDUAL....	4.11	5.14	4.70	5.22	5.82	6.32	6.64	6.94
HI-SULFUR RESIDUAL....	2.93	NA	4.19	4.72	5.34	5.86	6.18	6.49
LIQUID PETROLEUM GAS..	3.83	6.34	5.82	6.44	7.11	7.61	7.91	8.17
PET-CHEM FEEDSTOCK(3).	NA	7.88	6.72	7.41	8.25	8.92	9.34	9.63
OTHER(4)..............	NA	NA	5.18	5.71	6.35	6.88	7.21	7.45
ELECTRICITY	9.42	11.67	14.09	14.52	14.94	15.08	15.13	15.26
TRANSPORTATION(5)	6.72	9.91	7.75	8.43	9.21	9.78	10.07	10.21
DISTILLATE............	5.85	8.39	6.21	6.87	7.66	8.29	8.69	8.95
HI-SULFUR RESIDUAL....	2.93	3.97	3.64	4.13	4.68	5.16	5.45	5.74
GASOLINE(6)...........	7.57	11.32	8.69	9.47	10.35	10.97	11.29	11.41
JET FUEL(7)...........	3.69	7.51	6.59	7.23	8.04	8.68	9.08	9.34
LIQUID PETROLEUM GAS..	NA	NA	5.77	6.39	7.06	7.57	7.88	8.15
ELECTRICITY	NA	NA	16.62	17.17	17.68	17.88	17.96	18.05
ELECTRIC UTILITY FUEL	2.04	1.84	2.05	2.17	2.26	2.33	2.37	2.45
STEAM COAL............	1.58	1.71	1.74	1.76	1.78	1.79	1.82	1.86
NATURAL GAS...........	1.14	2.80	5.48	6.42	6.98	6.99	7.13	7.28
DISTILLATE(8).........	3.28	7.22	5.85	6.49	7.24	7.84	8.20	8.46
LO-SULFUR RESIDUAL(9).	3.27	5.90	4.79	5.32	5.94	6.46	6.69	6.95
HI-SULFUR RESIDUAL....	NA	4.55	3.67	4.15	4.70	5.16	5.45	5.74
NUCLEAR...............	NA	.85	0.85	0.85	0.85	0.85	0.85	0.85
REFINERY FUEL	NA	NA	2.30	2.59	2.90	3.14	3.28	3.39
NATURAL GAS...........	NA	3.08	4.69	5.49	6.05	6.18	6.22	6.23
DISTILLATE............	NA	6.09	5.14	5.70	6.36	6.90	7.23	7.46
LO-SULFUR RESIDUAL....	NA	NA	4.12	4.59	5.13	5.59	5.88	6.16
HI-SULFUR RESIDUAL....	NA	4.89	3.46	3.93	4.47	4.94	5.22	5.51
LIQUID PETROLEUM GAS..	NA	NA	5.12	5.69	6.29	6.75	7.02	7.28
OTHER(10).............	NA	NA	5.07	5.60	6.24	6.77	7.10	7.34

NOTE: TOTALS MAY NOT EQUAL SUM OF COMPONENTS DUE TO INDEPENDENT ROUNDING. FOR TABLE FOOTNOTES AND SOURCES SEE PAGE 219.

TABLE E.5.1. ELECTRIC UTILITY FUEL PRICES AND CONSUMPTION
CASE E: HIGH UTILIZATION OF EXISTING POWERPLANTS
(1982 DOLLARS PER MILLION BTU; TRILLIONS OF BTU PER YEAR)

YEARS	COAL	NATURAL GAS	DISTILLATE	LO-S RESID	HI-S RESID	FOSSIL FUEL	NUCLEAR	HYDRO	ALL FUELS
FUEL PRICES									
1980	1.71	2.80	7.22	5.90	4.55	NA	NA	--	NA
1985	1.74	5.48	5.83	4.79	3.67	2.61	0.85	--	2.05
1986	1.76	6.42	6.49	5.32	4.15	2.80	0.85	--	2.17
1987	1.78	6.98	7.22	5.94	4.70	2.97	0.85	--	2.26
1988	1.79	6.99	7.83	6.46	5.16	3.07	0.85	--	2.33
1989	1.82	7.13	8.17	6.69	5.46	3.14	0.85	--	2.37
1990	1.86	7.20	8.43	6.95	5.74	3.23	0.85	--	2.44
FUEL CONSUMPTION									
1980	12122.	3807.	121.	1611.	922.	18583.	2672.	2988.	24243.
1985	14307.	1625.	307.	2583.	1153.	19975.	4275.	3064.	27313.
1986	14691.	1635.	310.	2639.	1172.	20447.	4855.	3036.	28338.
1987	14962.	1679.	265.	2655.	1177.	20738.	5451.	3039.	29229.
1988	15386.	1800.	279.	2616.	1181.	21262.	5988.	3022.	30272.
1989	15884.	2120.	318.	2343.	1163.	21828.	6333.	3037.	31198.
1990	16597.	2334.	403.	2255.	1179.	22767.	6545.	3062.	32375.

NA=NOT AVAILABLE.
--=NOT APPLICABLE.
NOTE: ENTRIES FOR 1980 ARE HISTORICAL DATA.
SOURCES: ON PAGE 222, SEE 1; 2, PP 160-170, TABLES B1, B2, B3, AND B4; 2, PP 253-255, TABLE C9; 2, PP 262-263, TABLE C13; 2, PP 270-271, TABLE C17; AND 2, PP 290-291, TABLE C27.

TABLE E.5.2. END-USE ELECTRICITY PRICES AND CONSUMPTION
CASE E: HIGH UTILIZATION OF EXISTING POWERPLANTS
(1982 MILLS PER KWH; BILLION KWH PER YEAR)

YEARS	RESIDENTIAL	COMMERCIAL	TRANSPORTATION	INDUSTRIAL	AVG./TOTAL
END-USE PRICES					
1980	57.25	58.72	NA	39.82	50.82
1985	58.05	58.88	56.71	48.08	54.49
1986	59.73	60.70	58.57	49.55	56.11
1987	61.30	62.41	60.32	50.99	57.65
1988	61.74	62.99	61.01	51.44	58.07
1989	61.88	63.22	61.28	51.64	58.24
1990	62.24	63.59	61.59	52.07	58.57
END-USE CONSUMPTION					
1980	717.50	558.91	0.00	815.06	2091.47
1985	774.12	691.70	3.05	903.06	2371.93
1986	796.21	720.17	3.05	944.34	2463.77
1987	817.25	743.63	3.05	980.98	2544.91
1988	838.09	763.88	3.05	1032.37	2637.38
1989	859.36	788.32	3.05	1070.68	2721.40
1990	880.64	814.64	3.05	1127.20	2825.53

NA=NOT AVAILABLE.
NOTE: ENTRIES FOR 1980 ARE HISTORICAL DATA.
SOURCES: ON PAGE 222, SEE 1, PP 15-18; AND 2, PP 229-40, TABLES C1, C2, C3, AND C4.

Case F
Lower Switching Flexibility for Existing Powerplants

Some electric powerplants are capable of burning either of two input fuels, which allows the utility to choose the most economical one. This provides considerable flexibility since the input fuel can be switched in the event of changes in the relative prices of the fuels available to the utility.

In the midprice case, electric utilities in some regions are projected to begin switching from natural gas to oil as the relatively rapid escalation in the cost of natural gas causes its delivered price to utilities to approach, and even exceed, the corresponding residual fuel oil price. This study examines the effect of restricting such fuel switches. In the middle world oil price Case A, if there is evidence that in 1981 a utility burned two fuels and it is recorded as being duel fired then that capacity is allowed to use either fuel on the basis of economics.

In Case F, it is assumed that the present primary fuel must account for at least half of the total fuel inputs for each dual-fired unit for all future periods.

Currently, oil is the most expensive fossil fuel, so it generally serves as the alternate fuel. Coal is projected to maintain a significant economic advantage over both oil and natural gas, so it would not be involved in any fuel switching. However, limiting the dual-fired capability would have a considerable impact on utility oil and gas consumption. In 1985, it is projected that utility oil use would decline by 17 percent compared to the midprice case, while natural gas consumption would increase by 47 percent. This switch would continue throughout the decade and utility oil demand in 1990 would be 10 percent lower and natural gas consumption would be 17 percent higher.

Case F

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THE FOLLOWING SECTION OF TABLES ARE FOR THE:

CASE F:  LOWER SWITCHING FLEXIBILITY FOR EXISTING POWERPLANTS


THIS SECTION CONTAINS THE FOLLOWING TABLES:

  EXECUTIVE SUMMARY TABLES
      TABLE F.1.1.  YEARLY SUPPLY AND DISPOSITION OF TOTAL ENERGY
      TABLE F.1.2.  SUPPLY/DEMAND BALANCE
      TABLE F.1.3.  CONSUMPTION SUMMARY
      TABLE F.1.4.  PRICE SUMMARY

  ELECTRIC UTILITY TABLES
      TABLE F.5.1.  ELECTRIC UTILITY FUEL PRICES AND CONSUMPTION
      TABLE F.5.2.  END-USE ELECTRICITY PRICES AND CONSUMPTION

  PETROLEUM SUPPLY TABLE
      TABLE F.6.1.  ANNUAL SUPPLY AND DISPOSITION OF PETROLEUM

  NATURAL GAS SUPPLY TABLE
      TABLE F.7.1.  NATURAL GAS SUPPLY/DEMAND BALANCE
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TABLE F.1.1. YEARLY SUPPLY AND DISPOSITION OF TOTAL ENERGY
CASE F: LOWER SWITCHING FLEXIBILITY FOR EXISTING POWERPLANTS
(QUADRILLION BTU PER YEAR)

	1975	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
SUPPLY												
PRODUCTION												
PETROLEUM..........	20.1	20.5	20.4	20.6	20.5	20.6	20.4	20.5	20.5	20.4	20.2	19.3
NATURAL GAS........	19.6	20.1	19.9	18.2	17.5	17.1	15.4	14.9	15.0	15.7	16.3	16.7
COAL...............	15.2	19.2	19.1	19.1	19.4	19.4	20.3	20.9	21.4	22.1	22.8	23.9
NUCLEAR............	1.9	2.7	2.9	3.0	3.2	3.7	4.1	4.7	5.3	5.8	6.1	6.3
HYDRO/GEO/OTHER....	3.2	3.0	2.9	3.3	3.2	3.0	3.0	3.1	3.1	3.0	3.1	3.1
SUBTOTAL.........	60.1	65.5	65.2	64.2	63.7	63.8	63.2	64.0	65.1	67.0	68.5	69.3
NET IMPORTS												
CRUDE OIL..........	8.7	10.6	8.8	6.8	7.5	10.2	12.5	12.2	11.5	11.0	10.8	11.7
OTHER PETROLEUM....	3.8	2.9	2.6	2.1	2.5	2.9	3.1	3.1	3.1	3.0	3.0	3.0
NG (CONTRACTED)(1).	0.9	1.0	.9	.9	1.1	1.2	1.2	1.2	1.2	1.2	1.2	1.2
OTHER GAS(2).......	0.0	0.0	0.0	0.0	0.0	0.3	0.5	0.7	0.7	0.3	0.5	0.0
COAL AND COKE......	-1.7	-2.4	-2.9	-2.8	-2.6	-2.7	-2.9	-3.0	-3.2	-3.4	-3.6	-3.8
ELECTRICITY........	0.1	.2	.2	.2	.2	0.3	0.3	0.3	0.3	0.3	0.4	0.4
SUBTOTAL.........	11.7	12.3	9.6	7.3	8.6	12.3	14.8	14.6	13.6	12.5	11.8	12.6
SPR ADDITIONS(3)....	0.0	-.1	-.7	-.4	-.4	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3
STOCK WITHDRAWALS...	-1.1	-1.8	0.0	-.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL SUPPLY.........	70.7	75.9	74.1	70.9	71.9	75.9	77.7	78.2	78.5	79.2	80.0	81.6
CONSUMPTION												
NON-ELEC UTILITY FUEL												
PETROLEUM..........	29.5	31.5	29.9	28.6	29.2	30.8	32.2	31.9	31.3	30.7	30.4	30.3
NATURAL GAS(4).....	16.7	16.6	16.1	15.0	14.9	14.4	13.5	13.4	13.3	13.5	13.7	14.1
COAL...............	4.0	3.4	3.4	3.0	2.9	3.2	3.3	3.3	3.4	3.5	3.6	3.7
SUBTOTAL.........	50.2	51.4	49.4	46.4	47.0	48.4	49.0	48.6	48.0	47.8	47.7	48.2
ELECTRIC UTILITY FUEL												
PETROLEUM..........	3.2	2.7	2.2	1.8	1.5	2.6	3.4	3.5	3.5	3.5	3.5	3.6
NATURAL GAS........	3.2	3.8	3.8	3.3	3.4	3.2	2.5	2.5	2.5	2.6	2.7	2.8
COAL...............	8.8	12.1	12.7	12.7	13.2	13.5	14.2	14.5	14.8	15.2	15.7	16.3
NUCLEAR............	1.9	2.7	2.9	3.0	3.2	3.7	4.1	4.7	5.3	5.8	6.1	6.3
HYDRO/GEO/OTHER(5).	3.4	3.2	3.1	3.5	3.4	3.3	3.4	3.4	3.4	3.4	3.4	3.5
SUBTOTAL.........	20.5	24.5	24.7	24.3	24.7	26.0	27.2	28.2	29.1	30.1	31.0	32.1
TOTAL CONSUMPTION....	70.7	75.9	74.1	70.7	71.7	74.4	76.2	76.8	77.1	77.9	78.7	80.3
ADJUSTMENTS												
REFINERY LOSSES(6).	0.0	0.0	0.0	0.0	-0.1	0.0	0.1	0.1	0.1	0.2	0.2	0.2
DISCREPANCY(7).....	0.0	0.0	0.0	0.2	0.3	1.5	1.4	1.3	1.3	1.1	1.1	1.1
TOTAL DISPOSITION....	70.7	75.9	74.1	70.9	71.9	75.9	77.7	78.2	78.5	79.2	80.0	81.6

NOTE: THE "ANNUAL ENERGY REVIEW" FOR 1982 WILL CONTAIN LATER REVISIONS TO HISTORICAL DATA FOR 1975, 1980 AND 1982.
NOTE: TOTALS MAY NOT EQUAL SUM OF COMPONENTS DUE TO INDEPENDENT ROUNDING. FOR TABLE FOOTNOTES AND SOURCES SEE PAGE 219.

TABLE F.1.2. SUPPLY/DEMAND BALANCE
CASE F: LOWER SWITCHING FLEXIBILITY FOR EXISTING POWERPLANTS
(QUADRILLION BTU PER YEAR)

	1975	1980	1985	1986	1987	1988	1989	1990
DOMESTIC SUPPLY								
COAL	15.2	19.2	20.3	20.9	21.4	22.1	22.8	23.9
NATURAL GAS	19.6	19.9	15.4	14.9	15.0	15.7	16.3	16.7
PETROLEUM	20.1	20.5	20.4	20.5	20.5	20.4	20.2	19.3
NUCLEAR	1.9	2.7	4.1	4.7	5.3	5.8	6.1	6.3
OTHER(1)	3.2	3.0	3.0	3.1	3.1	3.0	3.1	3.1
TOTAL DOMESTIC SUPPLY	60.0	65.3	63.2	64.0	65.1	67.0	68.5	69.3
NATURAL GAS IMPORTS	0.9	1.0	1.2	1.2	1.2	1.2	1.2	1.2
SUPPLEMENTAL GAS(2)	0.0	0.2	0.5	0.7	0.7	0.3	0.0	0.0
PETROLEUM IMPORTS	12.5	13.5	15.6	15.3	14.6	14.0	13.8	14.8
TOTAL SUPPLY(3)	73.4	80.0	80.5	81.2	81.6	82.5	83.5	85.3
DISPOSITION								
RESIDENTIAL	9.6	9.3	9.2	9.2	9.2	9.2	9.2	9.2
COMMERCIAL	5.5	5.9	6.6	6.7	6.7	6.8	6.8	6.8
INDUSTRIAL(4)	21.3	23.0	22.1	22.4	22.5	22.9	23.3	24.0
TRANSPORTATION	17.7	19.7	18.6	18.2	17.7	17.3	17.0	16.9
TOTAL END-USE CONSUMPTION	54.1	57.9	56.5	56.5	56.2	56.1	56.3	57.1
DISCREPANCY	0.2	-0.1	0.0	-0.1	-0.2	-0.2	-0.3	-0.4
ADJUSTMENTS	19.1	22.2	24.0	24.8	25.6	26.6	27.5	28.6
UTILITY GENERATION	13.7	16.5	18.3	18.9	19.5	20.2	20.8	21.5
UTILITY TRANSMISSION	0.6	0.7	0.9	0.9	0.9	1.0	1.0	1.0
REFINERY(5)	0.0	0.0	0.1	0.1	0.1	0.2	0.2	0.2
GAS PIPELINE(6)	0.6	0.6	1.1	1.1	1.1	1.1	1.1	1.1
LEASE/PLANT FUEL(7)	1.4	1.0	1.2	1.1	1.1	1.2	1.2	1.3
COAL EXPORTS	1.7	2.4	2.9	3.0	3.2	3.4	3.6	3.8
SPR ADDITIONS	0.0	0.1	0.3	0.3	0.3	0.3	0.3	0.3
STOCK WITHDRAWALS	1.1	1.8	0.0	0.0	0.0	0.0	0.0	0.0
RECLASSIFIED	0.0	-0.9	-0.7	-0.7	-0.7	-0.6	-0.6	-0.6
ADJUSTED CONSUMPTION	73.4	80.0	80.5	81.2	81.6	82.5	83.5	85.3
ELECTRIC UTILITY FUEL								
COAL	8.8	12.1	14.2	14.5	14.8	15.2	15.7	16.3
PETROLEUM	3.2	2.7	3.4	3.5	3.5	3.5	3.5	3.6
NATURAL GAS	3.2	3.8	2.5	2.5	2.5	2.6	2.7	2.8
TOTAL FOSSIL	15.2	18.6	20.1	20.5	20.8	21.3	21.8	22.7
NUCLEAR	1.9	2.7	4.1	4.7	5.3	5.8	6.1	6.3
OTHER	3.2	3.0	3.0	3.1	3.1	3.0	3.1	3.1
TOTAL	20.3	24.3	27.2	28.2	29.1	30.1	31.0	32.1
GENERATION	6.6	7.8	8.9	9.3	9.6	9.9	10.2	10.6

NOTE: TOTALS MAY NOT EQUAL SUM OF COMPONENTS DUE TO INDEPENDENT ROUNDING. FOR TABLE FOOTNOTES AND SOURCES SEE PAGE 219.

TABLE F.1.3. CONSUMPTION SUMMARY
CASE F: LOWER SWITCHING FLEXIBILITY FOR EXISTING POWERPLANTS
(QUADRILLION BTU PER YEAR)

	1975	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
RESIDENTIAL	9.571	9.335	9.104	9.236	9.143	9.168	9.193	9.216	9.219	9.215	9.225	9.246
STEAM COAL.............	0.091	0.065	0.080	0.082	0.071	0.078	0.076	0.074	0.073	0.071	0.069	0.068
NATURAL GAS............	5.022	4.866	4.654	4.793	4.710	4.645	4.572	4.510	4.449	4.395	4.355	4.326
DISTILLATE(1)..........	1.923	1.417	1.375	1.303	1.230	1.308	1.329	1.337	1.332	1.319	1.303	1.286
LIQUID PETROLEUM GAS...	0.528	0.539	0.536	0.570	0.590	0.565	0.577	0.583	0.584	0.580	0.576	0.572
ELECTRICITY	2.007	2.448	2.459	2.488	2.530	2.572	2.639	2.712	2.781	2.851	2.922	2.994
COMMERCIAL	5.513	5.892	5.818	5.866	6.182	6.432	6.590	6.694	6.742	6.754	6.791	6.839
STEAM COAL.............	0.135	0.095	0.107	0.122	0.086	0.097	0.095	0.092	0.090	0.087	0.084	0.082
NATURAL GAS............	2.559	2.674	2.580	2.683	2.720	2.727	2.715	2.682	2.631	2.571	2.523	2.481
DISTILLATE(1)..........	0.622	0.556	0.540	0.511	0.670	0.738	0.775	0.802	0.816	0.822	0.826	0.829
LO-SULFUR RESIDUAL.....	0.506	0.566	0.470	0.376	0.490	0.542	0.569	0.589	0.599	0.603	0.607	0.609
LIQUID PETROLEUM GAS...	0.093	0.095	0.095	0.101	0.090	0.080	0.078	0.076	0.074	0.072	0.070	0.068
ELECTRICITY	1.598	1.906	2.026	2.074	2.150	2.248	2.358	2.453	2.532	2.599	2.681	2.770
INDUSTRIAL(2)	18.503	20.185	19.513	16.876	17.365	18.918	19.626	19.868	20.037	20.491	20.914	21.686
STEAM COAL.............	1.619	1.388	1.570	1.626	1.501	1.766	1.789	1.839	1.914	2.010	2.112	2.220
METALLURGICAL COAL.....	2.178	1.793	1.647	1.057	1.132	1.262	1.302	1.325	1.337	1.353	1.359	1.375
NATURAL GAS............	6.133	6.497	6.639	5.414	5.340	5.297	4.785	4.762	4.831	5.041	5.261	5.591
DISTILLATE.............	1.272	1.569	1.285	1.212	1.340	1.767	2.299	2.291	2.180	2.090	1.997	1.952
LO-SULFUR RESIDUAL.....	0.428	0.554	0.423	0.368	0.390	0.493	0.570	0.574	0.566	0.565	0.555	0.565
HI-SULFUR RESIDUAL.....	0.856	0.713	0.531	0.483	0.530	0.715	0.871	0.879	0.867	0.860	0.843	0.850
LIQUID PETROLEUM GAS...	0.252	0.308	0.323	0.332	0.370	0.368	0.389	0.362	0.316	0.269	0.222	0.184
PET-CHEM FEEDSTOCK(3)..	1.519	2.401	2.111	1.862	1.980	2.178	2.293	2.378	2.458	2.561	2.676	2.841
OTHER(4)...............	1.900	2.180	2.166	1.977	2.240	2.207	2.259	2.254	2.241	2.240	2.258	2.288
ELECTRICITY	2.346	2.781	2.817	2.545	2.620	2.866	3.069	3.204	3.327	3.503	3.630	3.821
TRANSPORTATION(5)	17.725	19.655	18.715	18.129	17.910	18.545	18.615	18.195	17.704	17.272	17.040	16.942
DISTILLATE.............	2.069	2.782	2.738	2.582	2.510	2.781	2.892	2.964	3.039	3.111	3.201	3.312
HI-SULFUR RESIDUAL.....	0.731	1.401	1.163	0.930	0.900	1.014	1.057	1.082	1.105	1.124	1.150	1.183
GASOLINE(6)............	12.868	13.253	12.688	12.528	12.180	12.476	12.294	11.717	11.085	10.526	10.130	9.833
JET FUEL(7)............	2.029	2.179	2.087	2.049	2.280	2.234	2.332	2.392	2.435	2.470	2.518	2.574
LIQUID PETROLEUM GAS...	0.016	0.014	0.014	0.015	0.020	0.015	0.015	0.015	0.015	0.015	0.015	0.015
OTHER..................	0.000	0.014	0.014	0.014	0.010	0.014	0.014	0.014	0.014	0.014	0.014	0.014
ELECTRICITY	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010
ELECTRIC UTILITY FUEL	20.360	24.243	24.462	24.203	24.480	25.960	27.226	28.218	29.079	30.094	31.002	32.138
STEAM COAL.............	8.790	12.122	12.707	12.697	13.190	13.534	14.155	14.519	14.785	15.195	15.660	16.332
NATURAL GAS............	3.240	3.807	3.764	3.336	3.440	3.153	2.499	2.474	2.506	2.602	2.703	2.804
DISTILLATE(8)..........	0.350	0.121	0.077	0.048	0.090	0.194	0.366	0.426	0.400	0.376	0.408	0.496
LO-SULFUR RESIDUAL(9)..	2.860	1.611	1.251	0.980	0.780	1.511	2.013	2.039	2.047	2.064	2.035	2.057
HI-SULFUR RESIDUAL.....	NA	0.922	0.898	0.789	0.600	0.876	1.035	1.026	1.028	1.031	1.017	1.028
HYDRO/GEO/OTHER(10)....	3.220	2.988	2.864	3.340	3.190	3.022	3.040	3.056	3.060	3.044	3.066	3.090
NUCLEAR................	1.900	2.672	2.901	3.013	3.190	3.671	4.118	4.678	5.253	5.782	6.114	6.331
REFINERY FUEL(11)	2.769	2.787	2.304	2.190	2.480	2.339	2.523	2.507	2.451	2.396	2.361	2.359
NATURAL GAS............	0.975	0.846	0.668	0.574	0.720	0.415	0.250	0.247	0.256	0.281	0.317	0.364
DISTILLATE.............	0.035	0.018	0.011	0.011	0.010	0.012	0.013	0.012	0.012	0.012	0.012	0.012
LO-SULFUR RESIDUAL.....	NA	NA	NA	NA	0.090	0.124	0.160	0.157	0.149	0.139	0.128	0.121
HI-SULFUR RESIDUAL.....	0.269	0.213	0.167	0.137	0.200	0.306	0.500	0.500	0.479	0.444	0.407	0.367
LIQUID PETROLEUM GAS...	0.050	0.043	0.024	0.038	0.030	0.025	0.027	0.027	0.027	0.026	0.026	0.026
OTHER(12)..............	0.390	0.436	0.359	0.348	0.360	0.363	0.392	0.389	0.380	0.372	0.366	0.366
STILL GAS..............	1.050	1.231	1.073	1.085	1.080	1.095	1.181	1.174	1.147	1.122	1.105	1.104

NOTE: TOTALS MAY NOT EQUAL SUM OF COMPONENTS DUE TO INDEPENDENT ROUNDING. FOR TABLE FOOTNOTES AND SOURCES SEE PAGE 219.

TABLE F.1.4. PRICE SUMMARY
CASE F: LOWER SWITCHING FLEXIBILITY FOR EXISTING POWERPLANTS
(1982 DOLLARS PER MILLION BTU)

	1975	1980	1985	1986	1987	1988	1989	1990
WORLD OIL PRICE.........	20.70	39.32	25.47	28.24	31.53	34.11	35.68	36.71
RESIDENTIAL	5.95	8.33	9.71	10.40	11.06	11.49	11.64	11.79
NATURAL GAS...........	2.75	4.16	6.88	7.58	8.17	8.55	8.55	8.59
DISTILLATE(1).........	4.75	8.59	6.27	6.93	7.72	8.35	8.75	9.02
LIQUID PETROLEUM GAS..	4.11	6.67	6.04	6.63	7.32	7.88	8.20	8.46
ELECTRICITY	15.61	16.78	17.34	17.83	18.30	18.42	18.43	18.45
COMMERCIAL	6.27	8.38	10.25	10.96	11.63	12.08	12.30	12.50
NATURAL GAS...........	2.17	3.84	6.65	7.39	8.01	8.41	8.47	8.54
DISTILLATE(1).........	4.30	8.06	5.93	6.56	7.31	7.91	8.29	8.55
LO-SULFUR RESIDUAL....	4.13	5.32	4.71	5.22	5.82	6.34	6.69	7.00
LIQUID PETROLEUM GAS..	NA	6.67	6.05	6.65	7.33	7.90	8.22	8.48
ELECTRICITY	15.55	17.21	17.60	18.12	18.63	18.79	18.81	18.83
INDUSTRIAL(2)	3.37	5.44	6.54	7.09	7.64	8.02	8.19	8.32
STEAM COAL............	1.81	1.55	2.10	2.13	2.16	2.20	2.24	2.33
METALLURGICAL COAL....	2.80	2.51	2.56	2.59	2.61	2.63	2.66	2.72
NATURAL GAS...........	1.49	2.90	5.87	6.60	7.16	7.42	7.39	7.29
DISTILLATE............	4.24	7.99	5.84	6.46	7.21	7.81	8.18	8.43
LO-SULFUR RESIDUAL....	4.11	5.14	4.64	5.14	5.72	6.24	6.58	6.89
HI-SULFUR RESIDUAL....	2.93	NA	4.12	4.63	5.24	5.77	6.12	6.44
LIQUID PETROLEUM GAS..	3.83	6.34	5.83	6.40	7.06	7.60	7.90	8.15
PET-CHEM FEEDSTOCK(3).	NA	7.88	6.72	7.41	8.25	8.92	9.35	9.64
OTHER(4)..............	NA	NA	5.17	5.70	6.34	6.87	7.20	7.44
ELECTRICITY	9.42	11.67	14.37	14.79	15.22	15.35	15.39	15.45
TRANSPORTATION(5)	6.72	9.91	7.74	8.42	9.20	9.77	10.06	10.21
DISTILLATE............	5.85	8.39	6.20	6.87	7.66	8.29	8.69	8.96
HI-SULFUR RESIDUAL....	2.93	3.97	3.58	4.04	4.59	5.07	5.39	5.69
GASOLINE(6)...........	7.57	11.32	8.69	9.47	10.35	10.97	11.28	11.41
JET FUEL(7)...........	3.69	7.51	6.59	7.23	8.04	8.68	9.08	9.35
LIQUID PETROLEUM GAS..	NA	NA	5.78	6.35	7.02	7.57	7.87	8.13
ELECTRICITY	NA	NA	16.97	17.51	18.02	18.21	18.25	18.25
ELECTRIC UTILITY FUEL	2.04	1.84	2.14	2.25	2.35	2.42	2.45	2.50
STEAM COAL............	1.58	1.71	1.74	1.75	1.77	1.79	1.81	1.86
NATURAL GAS...........	1.14	2.80	5.93	6.68	7.25	7.43	7.39	7.24
DISTILLATE(8).........	3.28	7.22	5.87	6.49	7.24	7.84	8.21	8.47
LO-SULFUR RESIDUAL(9).	3.27	5.90	4.69	5.20	5.80	6.32	6.67	6.98
HI-SULFUR RESIDUAL....	NA	4.55	3.61	4.06	4.61	5.08	5.39	5.69
NUCLEAR...............	NA	.85	0.85	0.85	0.85	0.85	0.85	0.85
REFINERY FUEL	NA	NA	2.29	2.57	2.88	3.14	3.28	3.39
NATURAL GAS...........	NA	3.08	5.02	5.67	6.23	6.51	6.46	6.31
DISTILLATE............	NA	6.09	5.14	5.70	6.36	6.90	7.24	7.47
LO-SULFUR RESIDUAL....	NA	NA	4.05	4.50	5.03	5.50	5.81	6.11
HI-SULFUR RESIDUAL....	NA	4.89	3.40	3.85	4.38	4.85	5.16	5.45
LIQUID PETROLEUM GAS..	NA	NA	5.13	5.65	6.25	6.74	7.02	7.25
OTHER(10).............	NA	NA	5.06	5.59	6.23	6.76	7.09	7.33

NOTE: TOTALS MAY NOT EQUAL SUM OF COMPONENTS DUE TO INDEPENDENT ROUNDING. FOR TABLE FOOTNOTES AND SOURCES SEE PAGE 219.

TABLE F.5.1. ELECTRIC UTILITY FUEL PRICES AND CONSUMPTION
CASE F: LOWER SWITCHING FLEXIBILITY FOR EXISTING POWERPLANTS
(1982 DOLLARS PER MILLION BTU; TRILLIONS OF BTU PER YEAR)

YEARS	COAL	NATURAL GAS	DISTILLATE	LO-S RESID	HI-S RESID	FOSSIL FUEL	NUCLEAR	HYDRO	ALL FUELS
FUEL PRICES									
1980	1.71	2.80	7.22	5.90	4.55	NA	NA	--	NA
1985	1.74	5.93	5.87	4.69	3.61	2.73	0.85	--	2.14
1986	1.75	6.68	6.48	5.20	4.07	2.91	0.85	--	2.25
1987	1.77	7.25	7.18	5.80	4.61	3.07	0.85	--	2.35
1988	1.79	7.43	7.83	6.32	5.08	3.19	0.85	--	2.42
1989	1.81	7.39	8.18	6.67	5.40	3.24	0.85	--	2.45
1990	1.86	7.24	8.40	6.98	5.69	3.30	0.85	--	2.50
FUEL CONSUMPTION									
1980	12122.	3807.	121.	1611.	922.	18583.	2672.	2988.	24243.
1985	14155.	2499.	366.	2013.	1035.	20067.	4118.	3040.	27226.
1956	14519.	2474.	426.	2039.	1026.	20484.	4678.	3056.	28218.
1987	14785.	2503.	400.	2047.	1028.	20763.	5253.	3060.	29076.
1988	15195.	2602.	376.	2064.	1031.	21268.	5782.	3044.	30094.
1989	15660.	2703.	408.	2035.	1017.	21822.	6114.	3066.	31082.
1990	16332.	2804.	496.	2057.	1028.	22717.	6331.	3090.	32138.

NA=NOT AVAILABLE.
--=NOT APPLICABLE.
NOTE: ENTRIES FOR 1980 ARE HISTORICAL DATA.
SOURCES: ON PAGE 222, SEE 1; 2, PP 160-170, TABLES B1, B2, B3, AND B4; 2, PP 253-255, TABLE C9; 2, PP 262-263, TABLE C13; 2, PP 270-271, TABLE C17; AND 2, PP 290-291, TABLE C27.

TABLE F.5.2. END-USE ELECTRICITY PRICES AND CONSUMPTION
CASE F: LOWER SWITCHING FLEXIBILITY FOR EXISTING POWERPLANTS
(1982 MILLS PER KWH; BILLION KWH PER YEAR)

YEARS	RESIDENTIAL	COMMERCIAL	TRANSPORTATION	INDUSTRIAL	AVG./TOTAL
END-USE PRICES					
1980	57.25	58.72	NA	39.82	50.82
1985	59.18	60.05	57.92	49.01	55.57
1986	60.83	61.84	59.74	50.47	57.16
1987	62.43	63.55	61.50	51.93	58.72
1988	62.85	64.10	62.14	52.39	59.12
1989	62.89	64.19	62.28	52.51	59.19
1990	62.96	64.25	62.27	52.72	59.25
END-USE CONSUMPTION					
1980	717.50	558.91	0.00	815.06	2091.47
1985	773.50	691.02	3.05	899.58	2367.14
1986	794.75	719.06	3.05	939.11	2455.97
1987	815.17	742.01	3.05	975.22	2535.45
1988	835.60	761.86	3.05	1026.70	2627.21
1989	856.49	785.80	3.05	1063.95	2709.29
1990	877.63	811.85	3.05	1119.92	2812.45

NA=NOT AVAILABLE.
NOTE: ENTRIES FOR 1980 ARE HISTORICAL DATA.
SOURCES: ON PAGE 222, SEE 1, PP 15-18; AND 2, PP 229-40, TABLES C1, C2, C3, AND C4.

TABLE F.6.1. ANNUAL SUPPLY AND DISPOSITION OF PETROLEUM
CASE F: LOWER SWITCHING FLEXIBILITY FOR EXISTING POWERPLANTS
(MILLIONS OF BARRELS PER DAY)

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
SUPPLY											
PRODUCTION											
CRUDE OIL	8.60	8.57	8.67	8.64	8.76	8.76	8.82	8.81	8.76	8.63	8.17
NORTH SLOPE	1.52	1.53	1.61	1.63	1.70	1.71	1.78	1.78	1.78	1.82	1.73
SUBARCTIC(1)	7.08	7.05	7.06	7.00	7.04	7.01	6.95	6.89	6.80	6.56	6.16
NATURAL GAS LIQUIDS	1.57	1.61	1.55	1.54	1.36	1.22	1.19	1.19	1.25	1.29	1.33
OTHER DOMESTIC(2)	0.04	0.05	0.05	0.05	0.02	0.04	0.09	0.14	0.19	0.24	0.29
PROCESSING GAIN	0.60	0.51	0.53	0.49	0.53	0.56	0.56	0.55	0.54	0.53	0.53
TOTAL PRODUCTION	10.81	10.74	10.81	10.72	10.65	10.54	10.56	10.55	10.55	10.45	10.04
IMPORTS(3)											
CRUDE OIL	5.26	4.40	3.46	3.75	5.08	6.15	5.99	5.68	5.41	5.34	5.78
REFINED PRODUCTS(4)	1.65	1.60	1.58	1.76	2.01	2.08	2.08	2.07	2.05	2.03	2.04
TOTAL IMPORTS	6.91	6.00	5.04	5.51	7.08	8.23	8.07	7.75	7.46	7.37	7.82
EXPORTS											
CRUDE OIL	0.29	0.23	0.24	0.23	0.25	0.25	0.25	0.25	0.25	0.25	0.25
REFINED PRODUCTS(4)	0.26	0.37	0.58	0.55	0.62	0.62	0.62	0.62	0.62	0.62	0.62
TOTAL EXPORTS	0.54	0.59	0.82	0.78	0.87	0.87	0.87	0.87	0.87	0.87	0.87
NET IMPORTS	6.37	5.40	4.23	4.72	6.21	7.36	7.20	6.88	6.59	6.50	6.95
PRIMARY STOCK CHANGES(5)											
NET WITHDRAWALS	-0.09	0.18	0.32	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SPR FILL RATE ADDITIONS(6)	-0.05	-0.34	-0.17	-0.21	-0.15	-0.15	-0.15	-0.15	-0.15	-0.15	-0.15
TOTAL PRIMARY SUPPLY	17.04	15.98	15.18	15.37	16.71	17.75	17.61	17.28	16.99	16.80	16.84
PRODUCT SUPPLIED											
MOTOR GASOLINE	6.86	6.59	6.54	6.36	6.54	6.42	6.12	5.79	5.50	5.29	5.13
DISTILLATE FUEL OIL	2.97	2.83	2.67	2.75	3.20	3.61	3.68	3.66	3.64	3.65	3.71
RESIDUAL FUEL OIL	2.56	2.09	1.69	1.73	2.43	2.95	2.98	2.98	2.98	2.94	2.96
OTHER PRODUCTS(7)	5.11	4.83	4.66	4.83	4.87	5.09	5.15	5.16	5.18	5.23	5.34
TOTAL RECLASSIFIED(8)	-0.44	-0.27	-0.31	-0.30	-0.30	-0.32	-0.31	-0.31	-0.30	-0.30	-0.30
TOTAL PRODUCT SUPPLIED	17.06	16.06	15.25	15.37	16.72	17.76	17.62	17.28	16.99	16.81	16.84
DISCREPANCY	-0.02	-0.08	-0.07	0.00	-0.01	-0.01	-0.01	-0.00	-0.00	-0.01	-0.00
NET DISPOSITION	17.04	15.98	15.18	15.37	16.71	17.75	17.61	17.28	16.99	16.80	16.84

(1) INCLUDES LOWER-48 STATES AND SOUTHERN ALASKA.
(2) OTHER DOMESTIC REPRESENTS OTHER HYDROCARBON INPUT.
(3) INCLUDES IMPORTS FOR THE STRATEGIC PETROLEUM RESERVE.
(4) CONSISTS OF NATURAL GAS PLANT LIQUIDS, UNFINISHED OILS, AND REFINED PRODUCT IMPORTS.
(5) EXCLUDES CRUDE OIL FOR THE STRATEGIC PETROLEUM RESERVE.
(6) ADDITIONS TO THE STRATEGIC PETROLEUM RESERVE (SHOWN AS NEGATIVE ENTRIES).
(7) COMPOSED OF JET FUEL, LIQUEFIED GASES, AND OTHER PRODUCTS.
(8) PETROLEUM PRODUCTS REPROCESSED INTO OTHER PRODUCT CATEGORIES.

NOTE: IN 1980, GASOLINE SUPPLIED HAS BEEN ADJUSTED TO CORRECT UNDERESTIMATION OF PRODUCT SUPPLIED. DISTILLATE AND RESIDUAL FUEL OIL HAVE BEEN RESTATED INTO THE NEW BASIS FOR COMPARABILITY PURPOSES.

NOTE: ENTRIES FOR 1980 ARE A COMBINATION OF HISTORICAL AND ESTIMATED VALUES.

SOURCES: ON PAGE 222, SEE 4, PAGE 6, TABLE 1; AND 20, PAGE 18, TABLE 7.

TABLE F.7.1. NATURAL GAS SUPPLY/DEMAND BALANCE
CASE F: LOWER SWITCHING FLEXIBILITY FOR EXISTING POWERPLANTS
(TRILLION BTU PER YEAR; 1982 DOLLARS PER MILLION BTU)

	1980	1985	1986	1987	1988	1989	1990
LOWER-48 ONSHORE SUPPLY	14435.	11463.	10898.	10815.	11517.	12257.	13043.
LOWER-48 OFFSHORE SUPPLY	5477.	3911.	4016.	4189.	4173.	4015.	3680.
TOTAL DOMESTIC SUPPLY	19912.	15374.	14914.	15004.	15690.	16272.	16723.
CATEGORY 102 (NEW GAS)	3439.	6322.	6788.	7539.	8537.	9634.	10308.
CATEGORY 104 (OLD INTERSTATE GAS)	8910.	5730.	4980.	4360.	3850.	3440.	3090.
CATEGORY 105 (OLD INTRASTATE GAS)	6899.	3050.	2750.	2550.	2370.	2110.	2000.
CATEGORY 107 (DEEP GAS)	664.	272.	396.	555.	933.	1088.	1325.
SUPPLEMENTAL GAS(1)	159.	468.	740.	660.	252.	0.	0.
IMPORTS	957.	1230.	1230.	1230.	1230.	1230.	1230.
TOTAL SUPPLY	21028.	17073.	16884.	16894.	17172.	17502.	17953.
LEASE AND PLANT FUEL(2)	1045.	1153.	1119.	1125.	1177.	1220.	1256.
TRANSPORTATION LOSS(3)	647.	1099.	1095.	1094.	1102.	1118.	1139.
CONSUMPTION BY SECTOR							
RESIDENTIAL	4866.	4572.	4510.	4449.	4395.	4355.	4526.
COMMERCIAL(4)	2674.	2715.	2682.	2631.	2571.	2523.	2481.
REFINERY	846.	250.	247.	256.	281.	317.	364.
ELECTRIC UTILITY	3807.	2499.	2474.	2506.	2602.	2703.	2804.
INDUSTRIAL(5)	6497.	4785.	4762.	4831.	5041.	5261.	5385.
TOTAL END-USE CONSUMPTION	18690.	14820.	14674.	14674.	14890.	15159.	15560.
DISCREPANCY(6)	-646.	0.	0.	0.	0.	0.	0.
WELLHEAD PRICES							
AVERAGE PRICE	1.79	3.85	4.47	5.10	5.48	5.42	5.25
CATEGORY 102 (NEW GAS)	2.69	4.93	5.60	6.14	6.40	6.17	5.85
CATEGORY 104 (OLD INTERSTATE GAS)	1.32	2.16	2.36	2.63	2.72	2.69	2.62
CATEGORY 105 (OLD INTRASTATE GAS)	1.67	4.70	5.32	6.01	6.27	6.06	5.77
CATEGORY 107 (DEEP GAS)	4.78	4.93	5.60	6.14	6.40	6.17	5.85
DELIVERED PRICE BY SECTOR							
RESIDENTIAL	4.16	6.88	7.58	8.17	8.55	8.55	8.59
COMMERCIAL(4)	3.04	6.65	7.39	8.01	8.41	8.47	8.54
REFINERY	3.08	5.02	5.67	6.23	6.51	6.46	6.31
ELECTRIC UTILITY	2.80	5.93	6.68	7.25	7.43	7.39	7.24
INDUSTRIAL(5)	2.90	5.87	6.60	7.16	7.42	7.39	7.29

(1) INCLUDES INCREASED GAS OR OIL IMPORTS.
(2) REPRESENTS GAS USED AS A FUEL IN FIELD GATHERING AND PLANT PROCESSING MACHINERY.
(3) INDICATES GAS USED TO FUEL COMPRESSORS IN THE PIPELINE MACHINERY.
(4) COMMERCIAL IS AN AGGREGATE OF COMMERCIAL AND OTHER CATEGORIES.
(5) EXCLUDES LEASE AND PLANT FUEL CONSUMPTION.
(6) REPRESENTS IMBALANCES RESULTING FROM THE MERGER OF DATA REPORTING SYSTEMS WHICH VARY IN SCOPE, FORMAT, DEFINITIONS AND TYPE OF RESPONDANTS.
NOTE: ENTRIES FOR 1980 ARE A COMBINATION OF HISTORICAL AND ESTIMATED VALUES.
SOURCES: ON PAGE 222, SEE 1, PP 15-19; 12, PAGE 7, TABLE 1; 13, PAGE 133, TABLE A7.

Case G
Higher Coal Transportation Rates

In this study, it is assumed that the cost of transporting coal by rail is increased over the middle world oil price case by 10 percent per year, beginning in 1984. The higher rail costs would have little impact on total coal consumption, but it would have considerable effect on coal exports and the regional distribution of U.S. coal production.

The increase in rail transportation costs would lower projected domestic coal consumption by only 2.1 percent in 1990. Utility coal demand would remain about the same because coal would continue to be the least expensive fossil fuel despite the higher rail costs. Also, the relatively long construction periods for new powerplants would inhibit any substantial shift away from coal. Utilities would primarily respond by shifting procurement toward closer supply sources and emphasizing water transportation where feasible.

The major changes in the disposition of coal would occur in the industrial sector and the level of exports. Industrial users are generally more responsive than electric utilities because their planning horizon is shorter. In this study, industrial and metallurgical coal consumption in 1990 is about 5.5 percent lower than in the midprice case and accounts for virtually all of the slight decrease in total domestic consumption.

Importers of U.S. coal would react to higher rail rates by shifting to alternate sources of supply outside the United States. Consequently, projected U.S. exports of coal would decrease by about 21.5 percent in 1990.

The changing demands brought about by higher rail rates would principally effect coal production in the eastern and western regions. In 1990, eastern coal supply would be about 4.5 percent lower than in the midprice case while western coal production would decrease by about 5.2 percent. The decline in eastern coal production would be moderate compared to the western region because its lower exports are offset somewhat by an increase in its utility coal demand.

Case G

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THE FOLLOWING SECTION OF TABLES ARE FOR THE:

CASE G:  HIGHER COAL TRANSPORTATION RATES


THIS SECTION CONTAINS THE FOLLOWING TABLES:

  EXECUTIVE SUMMARY TABLES
      TABLE G.1.1.  YEARLY SUPPLY AND DISPOSITION OF TOTAL ENERGY
      TABLE G.1.2.  SUPPLY/DEMAND BALANCE
      TABLE G.1.3.  CONSUMPTION SUMMARY
      TABLE G.1.4.  PRICE SUMMARY

  COAL SUPPLY TABLE
      TABLE G.8.1.  COAL SUPPLY AND DISPOSITION
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TABLE G.1.1. YEARLY SUPPLY AND DISPOSITION OF TOTAL ENERGY
CASE G: HIGHER COAL TRANSPORTATION RATES
(QUADRILLION BTU PER YEAR)

	1975	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
SUPPLY												
PRODUCTION												
PETROLEUM..........	20.1	20.5	20.4	20.6	20.5	20.6	20.4	20.5	20.5	20.5	20.3	19.3
NATURAL GAS........	19.6	20.1	19.9	18.2	17.5	17.0	15.2	14.7	14.7	15.3	15.8	16.3
COAL...............	15.2	19.2	19.1	19.1	19.4	19.2	19.9	20.3	20.7	21.2	21.8	22.6
NUCLEAR............	1.9	2.7	2.9	3.0	3.2	3.7	4.1	4.7	5.3	5.8	6.1	6.3
HYDRO/GEO/OTHER....	3.2	3.0	2.9	3.3	3.2	3.1	3.1	3.1	3.2	3.2	3.2	3.2
SUBTOTAL.........	60.1	65.5	65.2	64.2	63.7	63.7	62.7	63.3	64.3	65.9	67.2	67.8
NET IMPORTS												
CRUDE OIL..........	8.7	10.6	8.8	6.8	7.5	10.4	12.9	12.6	12.0	11.3	11.0	11.8
OTHER PETROLEUM....	3.8	2.9	2.6	2.1	2.5	3.0	3.1	3.1	3.1	3.1	3.1	3.1
NG (CONTRACTED)(1).	0.9	1.0	.9	.9	1.1	1.2	1.2	1.2	1.2	1.2	1.2	1.2
OTHER GAS(2).......	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.2	0.0	0.0	0.0
COAL AND COKE......	-1.7	-2.4	-2.9	-2.8	-2.6	-2.5	-2.5	-2.6	-2.6	-2.7	-2.9	-3.0
ELECTRICITY........	0.1	.2	.2	.2	.2	0.3	0.3	0.3	0.3	0.3	0.4	0.4
SUBTOTAL.........	11.7	12.3	9.6	7.3	8.6	12.4	15.1	15.0	14.2	13.2	12.8	13.5
SPR ADDITIONS(3)....	0.0	-.1	-.7	-.4	-.4	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3
STOCK WITHDRAWALS...	-1.1	-1.8	0.0	-.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL SUPPLY.........	70.7	75.9	74.1	70.9	71.9	75.8	77.5	78.0	78.2	78.9	79.7	81.1
CONSUMPTION												
NON-ELEC UTILITY FUEL												
PETROLEUM..........	29.5	31.5	29.9	28.6	29.2	30.7	32.1	31.8	31.2	30.6	30.3	30.3
NATURAL GAS(4).....	16.7	16.6	16.1	15.0	14.9	14.5	13.7	13.5	13.5	13.7	13.9	14.1
COAL...............	4.0	3.4	3.4	3.0	2.9	3.2	3.3	3.3	3.4	3.4	3.5	3.6
SUBTOTAL.........	50.2	51.4	49.4	46.4	47.0	48.4	49.0	48.6	48.0	47.7	47.7	48.0
ELECTRIC UTILITY FUEL												
PETROLEUM..........	3.2	2.7	2.2	1.8	1.5	2.9	4.1	4.2	4.1	4.1	3.8	3.8
NATURAL GAS........	3.2	3.8	3.8	3.3	3.4	2.7	1.7	1.7	1.7	1.8	2.1	2.3
COAL...............	8.8	12.1	12.7	12.7	13.2	13.5	14.1	14.4	14.7	15.0	15.4	16.1
NUCLEAR............	1.9	2.7	2.9	3.0	3.2	3.7	4.1	4.7	5.3	5.8	6.1	6.3
HYDRO/GEO/OTHER(5).	3.4	3.2	3.1	3.5	3.4	3.4	3.5	3.5	3.5	3.5	3.5	3.6
SUBTOTAL.........	20.5	24.5	24.7	24.3	24.7	25.9	27.2	28.1	28.9	29.9	30.7	31.7
TOTAL CONSUMPTION....	70.7	75.9	74.1	70.7	71.7	74.4	76.2	76.7	76.9	77.6	78.4	79.8
ADJUSTMENTS												
REFINERY LOSSES(6).	0.0	0.0	0.0	0.0	-0.1	0.0	0.2	0.2	0.2	0.2	0.2	0.2
DISCREPANCY(7).....	0.0	0.0	0.0	0.2	0.3	1.4	1.1	1.1	1.1	1.1	1.1	1.1
TOTAL DISPOSITION....	70.7	75.9	74.1	70.9	71.9	75.8	77.5	78.0	78.2	78.9	79.7	81.1

NOTE: THE "ANNUAL ENERGY REVIEW" FOR 1982 WILL CONTAIN LATER REVISIONS TO HISTORICAL DATA FOR 1975, 1980 AND 1982.
NOTE: TOTALS MAY NOT EQUAL SUM OF COMPONENTS DUE TO INDEPENDENT ROUNDING. FOR TABLE FOOTNOTES AND SOURCES SEE PAGE 219.

TABLE G.1.2. SUPPLY/DEMAND BALANCE
CASE G: HIGHER COAL TRANSPORTATION RATES
(QUADRILLION BTU PER YEAR)

	1975	1980	1985	1986	1987	1988	1989	1990
DOMESTIC SUPPLY								
COAL..................	15.2	19.2	19.9	20.3	20.7	21.2	21.8	22.6
NATURAL GAS...........	19.6	19.9	15.2	14.7	14.7	15.3	15.8	16.3
PETROLEUM.............	20.1	20.5	20.4	20.5	20.5	20.5	20.3	19.3
NUCLEAR...............	1.9	2.7	4.1	4.7	5.3	5.8	6.1	6.3
OTHER(1)..............	3.2	3.0	3.1	3.1	3.2	3.2	3.2	3.2
TOTAL DOMESTIC SUPPLY.................	60.0	65.3	62.7	63.3	64.3	65.9	67.2	67.8
NATURAL GAS IMPORTS...	0.9	1.0	1.2	1.2	1.2	1.2	1.2	1.2
SUPPLEMENTAL GAS(2)...	0.0	0.2	0.0	0.3	0.2	0.0	0.0	0.0
PETROLEUM IMPORTS.....	12.5	13.5	16.0	15.8	15.1	14.4	14.0	14.9
TOTAL SUPPLY(3).........	73.4	80.0	80.0	80.6	80.8	81.6	82.5	84.0
DISPOSITION								
RESIDENTIAL...........	9.6	9.3	9.2	9.2	9.2	9.2	9.2	9.2
COMMERCIAL............	5.5	5.9	6.6	6.7	6.8	6.8	6.8	6.8
INDUSTRIAL(4).........	21.3	23.9	22.1	22.3	22.4	22.8	23.1	23.8
TRANSPORTATION........	17.7	19.7	18.6	18.2	17.7	17.3	17.0	16.9
TOTAL END-USE CONSUMPTION.............	54.1	57.9	56.6	56.5	56.1	56.1	56.2	56.8
DISCREPANCY.............	0.2	-0.1	-0.2	-0.2	-0.3	-0.4	-0.3	-0.3
ADJUSTMENTS.............	19.1	22.2	23.6	24.3	25.0	25.9	26.6	27.5
UTILITY GENERATION....	13.7	16.5	18.3	18.9	19.4	20.1	20.6	21.3
UTILITY TRANSMISSION..	0.6	0.7	0.9	0.9	0.9	0.9	1.0	1.0
REFINERY(5)...........	0.0	0.0	0.2	0.2	0.2	0.2	0.2	0.2
GAS PIPELINE(6).......	0.6	0.6	1.1	1.0	1.0	1.1	1.1	1.1
LEASE/PLANT FUEL(7)...	1.4	1.0	1.1	1.1	1.1	1.1	1.2	1.2
COAL EXPORTS..........	1.7	2.4	2.5	2.6	2.6	2.7	2.9	3.0
SPR ADDITIONS.........	0.0	0.1	0.3	0.3	0.3	0.3	0.3	0.3
STOCK WITHDRAWALS.....	1.1	1.8	0.0	0.0	0.0	0.0	0.0	0.0
RECLASSIFIED..........	0.0	-0.9	-0.7	-0.7	-0.7	-0.6	-0.6	-0.6
ADJUSTED CONSUMPTION....	73.4	80.0	80.0	80.6	80.8	81.6	82.5	84.0
ELECTRIC UTILITY FUEL								
COAL..................	8.8	12.1	14.1	14.4	14.7	15.0	15.4	16.1
PETROLEUM.............	3.2	2.7	4.1	4.2	4.1	4.1	3.8	3.8
NATURAL GAS...........	3.2	3.8	1.7	1.7	1.7	1.8	2.1	2.3
TOTAL FOSSIL............	15.2	18.6	19.9	20.3	20.5	20.9	21.4	22.2
NUCLEAR...............	1.9	2.7	4.1	4.7	5.3	5.8	6.1	6.3
OTHER.................	3.2	3.0	3.1	3.1	3.2	3.2	3.2	3.2
TOTAL...................	20.3	24.3	27.2	28.1	28.9	29.9	30.7	31.7
GENERATION..............	6.6	7.8	8.9	9.2	9.5	9.8	10.1	10.5

NOTE: TOTALS MAY NOT EQUAL SUM OF COMPONENTS DUE TO INDEPENDENT ROUNDING. FOR TABLE FOOTNOTES AND SOURCES SEE PAGE 219.

TABLE 0.1.3. CONSUMPTION SUMMARY
CASE G: HIGHER COAL TRANSPORTATION RATES
(QUADRILLION BTU PER YEAR)

	1975	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
RESIDENTIAL	9.571	9.335	9.104	9.236	9.143	9.173	9.205	9.226	9.228	9.225	9.232	9.246
STEAM COAL.............	0.091	0.065	0.080	0.082	0.071	0.078	0.076	0.074	0.073	0.071	0.069	0.068
NATURAL GAS............	5.022	4.866	4.654	4.793	4.710	4.650	4.586	4.523	4.465	4.415	4.378	4.348
DISTILLATE(1)..........	1.923	1.417	1.375	1.303	1.230	1.308	1.328	1.336	1.332	1.318	1.302	1.286
LIQUID PETROLEUM GAS...	0.528	0.539	0.536	0.570	0.590	0.565	0.576	0.582	0.582	0.579	0.575	0.571
ELECTRICITY	2.007	2.448	2.459	2.488	2.530	2.573	2.639	2.710	2.777	2.842	2.908	2.973
COMMERCIAL	5.513	5.892	5.818	5.866	6.182	6.437	6.600	6.706	6.754	6.768	6.805	6.849
STEAM COAL.............	0.135	0.095	0.107	0.122	0.086	0.097	0.095	0.092	0.090	0.087	0.085	0.083
NATURAL GAS............	2.559	2.674	2.580	2.683	2.720	2.731	2.723	2.692	2.644	2.588	2.543	2.501
DISTILLATE(1)..........	0.622	0.556	0.540	0.511	0.670	0.738	0.775	0.801	0.815	0.820	0.824	0.827
LO-SULFUR RESIDUAL.....	0.506	0.566	0.470	0.376	0.490	0.542	0.569	0.588	0.598	0.602	0.605	0.608
LIQUID PETROLEUM GAS...	0.093	0.095	0.095	0.101	0.090	0.080	0.078	0.076	0.074	0.072	0.070	0.068
ELECTRICITY	1.598	1.906	2.026	2.074	2.150	2.250	2.360	2.455	2.533	2.599	2.678	2.763
INDUSTRIAL(2)	18.503	20.185	19.513	16.876	17.365	18.894	19.582	19.788	19.931	20.376	20.763	21.448
STEAM COAL.............	1.619	1.388	1.570	1.626	1.501	1.770	1.791	1.826	1.884	1.963	2.044	2.114
METALLURGICAL COAL.....	2.178	1.793	1.647	1.057	1.132	1.257	1.292	1.307	1.312	1.321	1.319	1.324
NATURAL GAS............	6.133	6.497	6.639	5.414	5.340	5.340	4.911	4.834	4.901	5.167	5.359	5.626
DISTILLATE.............	1.272	1.569	1.285	1.212	1.340	1.750	2.228	2.255	2.153	2.046	1.973	1.959
LO-SULFUR RESIDUAL.....	0.428	0.554	0.423	0.367	0.390	0.485	0.552	0.561	0.554	0.550	0.547	0.565
HI-SULFUR RESIDUAL.....	0.856	0.713	0.531	0.484	0.530	0.703	0.836	0.853	0.842	0.827	0.819	0.835
LIQUID PETROLEUM GAS...	0.252	0.308	0.323	0.332	0.370	0.366	0.384	0.359	0.313	0.266	0.219	0.183
PET-CHEM FEEDSTOCK(3)..	1.519	2.401	2.111	1.862	1.980	2.176	2.292	2.373	2.453	2.559	2.674	2.838
OTHER(4)...............	1.900	2.180	2.166	1.977	2.240	2.207	2.259	2.253	2.241	2.239	2.257	2.288
ELECTRICITY	2.346	2.781	2.817	2.545	2.620	2.840	3.038	3.167	3.278	3.438	3.551	3.717
TRANSPORTATION(5)	17.725	19.655	18.715	18.129	17.910	18.538	18.607	18.185	17.695	17.261	17.030	16.933
DISTILLATE.............	2.069	2.782	2.738	2.582	2.510	2.781	2.892	2.964	3.038	3.110	3.199	3.310
HI-SULFUR RESIDUAL.....	0.731	1.401	1.163	0.930	0.900	1.012	1.054	1.079	1.102	1.122	1.148	1.181
GASOLINE(6)............	12.868	13.253	12.688	12.528	12.180	12.471	12.289	11.711	11.080	10.521	10.125	9.828
JET FUEL(7)............	2.029	2.179	2.087	2.049	2.280	2.234	2.331	2.391	2.435	2.469	2.517	2.574
LIQUID PETROLEUM GAS...	0.016	0.014	0.014	0.015	0.020	0.015	0.015	0.015	0.015	0.015	0.015	0.015
OTHER..................	0.000	0.014	0.014	0.014	0.010	0.014	0.014	0.014	0.014	0.014	0.014	0.014
ELECTRICITY	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010
ELECTRIC UTILITY FUEL	20.360	24.243	24.462	24.203	24.480	25.924	27.174	28.122	28.941	29.895	30.719	31.744
STEAM COAL.............	8.790	12.122	12.707	12.697	13.190	13.528	14.120	14.431	14.671	15.010	15.449	16.078
NATURAL GAS............	3.240	3.807	3.764	3.336	3.440	2.700	1.687	1.674	1.715	1.829	2.137	2.331
DISTILLATE(8)..........	0.350	0.121	0.077	0.048	0.090	0.180	0.343	0.365	0.314	0.313	0.344	0.414
LO-SULFUR RESIDUAL(9)..	2.860	1.611	1.251	0.980	0.780	1.784	2.592	2.635	2.642	2.598	2.313	2.195
HI-SULFUR RESIDUAL.....	NA	0.922	0.898	0.789	0.600	0.945	1.181	1.190	1.193	1.194	1.175	1.183
HYDRO/GEO/OTHER(10)....	3.220	2.988	2.864	3.340	3.190	3.115	3.133	3.149	3.153	3.168	3.185	3.212
NUCLEAR................	1.900	2.672	2.901	3.013	3.190	3.671	4.118	4.678	5.253	5.782	6.114	6.331
REFINERY FUEL(11)	2.769	2.787	2.304	2.190	2.480	2.357	2.562	2.548	2.491	2.432	2.380	2.369
NATURAL GAS............	0.975	0.846	0.668	0.574	0.720	0.438	0.299	0.281	0.289	0.326	0.350	0.381
DISTILLATE.............	0.035	0.018	0.011	0.011	0.010	0.012	0.013	0.013	0.012	0.012	0.012	0.012
LO-SULFUR RESIDUAL.....	NA	NA	NA	NA	0.090	0.118	0.151	0.151	0.143	0.130	0.122	0.118
HI-SULFUR RESIDUAL.....	0.269	0.213	0.167	0.137	0.200	0.295	0.475	0.488	0.467	0.421	0.387	0.356
LIQUID PETROLEUM GAS...	0.050	0.043	0.024	0.038	0.030	0.026	0.028	0.028	0.027	0.026	0.026	0.026
OTHER(12)..............	0.390	0.436	0.359	0.348	0.360	0.366	0.397	0.395	0.387	0.377	0.369	0.367
STILL GAS..............	1.050	1.231	1.073	1.085	1.080	1.103	1.199	1.193	1.166	1.139	1.114	1.109

NOTE: TOTALS MAY NOT EQUAL SUM OF COMPONENTS DUE TO INDEPENDENT ROUNDING. FOR TABLE FOOTNOTES AND SOURCES SEE PAGE 219.

TABLE 0.1.4. PRICE SUMMARY
CASE G: HIGHER COAL TRANSPORTATION RATES
(1982 DOLLARS PER MILLION BTU)

	1975	1980	1985	1986	1987	1988	1989	1990
WORLD OIL PRICE.........	20.70	39.32	25.47	28.24	31.53	34.11	35.68	36.71
RESIDENTIAL	5.95	8.33	9.57	10.35	11.04	11.44	11.68	11.99
NATURAL GAS...........	2.75	4.16	6.64	7.43	8.01	8.26	8.32	8.50
DISTILLATE(1).........	4.75	8.59	6.27	6.93	7.72	8.35	8.75	9.02
LIQUID PETROLEUM GAS..	4.11	6.67	6.04	6.67	7.36	7.89	8.19	8.47
ELECTRICITY	15.61	16.78	17.29	17.90	18.50	18.76	18.94	19.25
COMMERCIAL	6.27	8.38	10.13	10.92	11.64	12.09	12.40	12.77
NATURAL GAS...........	2.17	3.84	6.41	7.23	7.84	8.12	8.24	8.44
DISTILLATE(1).........	4.30	8.06	5.94	6.56	7.31	7.91	8.29	8.55
LO-SULFUR RESIDUAL....	4.13	5.32	4.78	5.30	5.91	6.43	6.74	7.05
LIQUID PETROLEUM GAS..	NA	6.67	6.05	6.68	7.38	7.90	8.21	8.49
ELECTRICITY	15.55	17.21	17.52	18.17	18.88	19.09	19.29	19.59
INDUSTRIAL(2)	3.37	5.44	6.49	7.10	7.69	8.07	8.30	8.55
STEAM COAL............	1.81	1.55	2.24	2.36	2.50	2.66	2.83	3.09
METALLURGICAL COAL....	2.80	2.51	2.65	2.74	2.82	2.92	3.02	3.19
NATURAL GAS...........	1.49	2.90	5.61	6.44	6.99	7.11	7.15	7.19
DISTILLATE............	4.24	7.99	5.84	6.47	7.21	7.81	8.18	8.43
LO-SULFUR RESIDUAL....	4.11	5.14	4.70	5.22	5.81	6.32	6.63	6.93
HI-SULFUR RESIDUAL....	2.93	NA	4.19	4.72	5.33	5.85	6.17	6.48
LIQUID PETROLEUM GAS..	3.83	6.34	5.83	6.44	7.10	7.61	7.90	8.16
PET-CHEM FEEDSTOCK(3).	NA	7.88	6.72	7.41	8.25	8.92	9.34	9.63
OTHER(4)..............	NA	NA	5.18	5.71	6.35	6.88	7.21	7.45
ELECTRICITY	9.42	11.67	14.33	14.89	15.44	15.70	15.91	16.25
TRANSPORTATION(5)	6.72	9.91	7.75	8.43	9.21	9.78	10.07	10.21
DISTILLATE............	5.85	8.39	6.21	6.87	7.66	8.29	8.69	8.96
HI-SULFUR RESIDUAL....	2.93	3.97	3.65	4.12	4.68	5.15	5.44	5.73
GASOLINE(6)...........	7.57	11.32	8.69	9.47	10.35	10.97	11.29	11.41
JET FUEL(7)...........	3.69	7.51	6.59	7.23	8.04	8.68	9.08	9.34
LIQUID PETROLEUM GAS..	NA	NA	5.78	6.39	7.06	7.57	7.87	8.14
ELECTRICITY	NA	NA	16.89	17.55	18.19	18.52	18.73	19.01
ELECTRIC UTILITY FUEL	2.04	1.84	2.12	2.26	2.39	2.49	2.57	2.70
STEAM COAL............	1.58	1.71	1.84	1.91	1.99	2.09	2.20	2.37
NATURAL GAS...........	1.14	2.80	5.52	6.43	6.99	7.00	7.12	7.19
DISTILLATE(8).........	3.28	7.22	5.87	6.50	7.24	7.84	8.21	8.47
LO-SULFUR RESIDUAL(9).	3.27	5.99	4.78	5.31	5.92	6.44	6.66	6.91
HI-SULFUR RESIDUAL....	NA	4.55	3.67	4.14	4.69	5.16	5.44	5.73
NUCLEAR...............	NA	.85	0.85	0.85	0.85	0.85	0.85	0.85
REFINERY FUEL	NA	NA	2.30	2.59	2.90	3.14	3.28	3.38
NATURAL GAS...........	NA	3.08	4.74	5.49	6.05	6.19	6.21	6.21
DISTILLATE............	NA	6.09	5.14	5.70	6.36	6.90	7.24	7.46
LO-SULFUR RESIDUAL....	NA	NA	4.12	4.58	5.13	5.59	5.87	6.15
HI-SULFUR RESIDUAL....	NA	4.89	3.46	3.93	4.47	4.93	5.21	5.49
LIQUID PETROLEUM GAS..	NA	NA	5.13	5.69	6.29	6.75	7.01	7.26
OTHER(10).............	NA	NA	5.07	5.60	6.24	6.77	7.10	7.34

NOTE: TOTALS MAY NOT EQUAL SUM OF COMPONENTS DUE TO INDEPENDENT ROUNDING. FOR TABLE FOOTNOTES AND SOURCES SEE PAGE 219.

TABLE G.8.1. COAL SUPPLY AND DISPOSITION
CASE G: HIGHER COAL TRANSPORTATION RATES
(MILLIONS OF SHORT TONS PER YEAR)

	1980	1985	1986	1987	1988	1989	1990
DOMESTIC SUPPLY							
EASTERN..............	579.	592.	604.	614.	627.	641.	661.
WESTERN..............	251.	305.	314.	322.	334.	349.	368.
NET IMPORTS(1).......	-91.	-95.	-97.	-100.	-104.	-108.	-113.
STOCK WITHDRAWALS....	-36.	0.	0.	0.	0.	0.	0.
TOTAL SUPPLY..........	703.	803.	820.	835.	857.	882.	916.
CONSUMPTION							
RESIDENTIAL/COMM....	7.	7.	7.	7.	7.	6.	6.
INDUSTRIAL..........	60.	76.	77.	79.	82.	85.	87.
METALLURGICAL.......	67.	49.	49.	49.	50.	50.	50.
ELECTRIC UTILITY....	569.	666.	681.	694.	713.	736.	767.
SYNTHETIC USE.......	0.	5.	5.	5.	5.	5.	5.
TOTAL CONSUMPTION.....	703.	803.	820.	835.	857.	882.	916.
TOTAL DISPOSITION.....	703.	803.	820.	835.	857.	882.	916.

(1) EXPORTS TO EUROPE AND JAPAN.

NOTE: EASTERN INCLUDES PENSYLVANIA, OHIO, MARYLAND, WEST VIRGINIA, VIRGINIA, KENTUCKY, TENNESSEE, ALABAMA, ILLINOIS, AND INDIANA. WESTERN INCLUDES IOWA, MISSOURI, KANSAS, ARKANSAS, OKLAHOMA, TEXAS, NORTH DAKOTA, SOUTH DAKOTA, MONTANA, WYOMING, COLORADO, UTAH, ARIZONA, NEW MEXICO, WASHINGTON, AND ALASKA.

NOTE: ENTRIES FOR 1980 ARE HISTORICAL DATA, AND STOCK WITHDRAWALS INCLUDES DISCREPANCY.

Case H
Low Industrial Electricity Demand

In this study it is assumed that the trend in electricity demand in the industrial sector will be similar to that experienced in the period 1963 to 1973 when the economy grew in a similar fashion.

However, there is substantial uncertainty about the amount of electricity needed to power the U.S. industrial sector throughout the projection period. This uncertainty stems from 2 different causes. First, cycles in the overall level of economic activity make it difficult to predict accurately which industrial activities will experience the most growth through 1990. Each type of activity uses a particular mix of energy, and energy intensity levels also differ across industries. Changes in the growth of individual industrial activities will change the overall demand for energy and electricity.

The second cause of uncertainty in the industrial electricity demand projections can be characterized as uncertainty with respect to the availability and rate of implementation of energy conservation measures by industrial concerns. Because trend variables are used in forecasting to capture these changes, an alternative specification of the rate at which they can be expected to occur was developed to show the implications of variations in these trends for industrial energy consumption. A "Low Industrial Electricity Demand" sensitivity case shows industrial electricity consumption may be as much as 290 trillion Btu lower in 1990. This would imply an alternative rate of growth in industrial electricity of 2.4 percent between 1980 and 1990. The full results of this sensitivity analysis are shown in Case H.

Case H

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THE FOLLOWING SECTION OF TABLES ARE FOR THE:

CASE H:  LOW INDUSTRIAL ELECTRICITY DEMAND


THIS SECTION CONTAINS THE FOLLOWING TABLES:

  EXECUTIVE SUMMARY TABLES
      TABLE H.1.1.  YEARLY SUPPLY AND DISPOSITION OF TOTAL ENERGY
      TABLE H.1.2.  SUPPLY/DEMAND BALANCE
      TABLE H.1.3.  CONSUMPTION SUMMARY
      TABLE H.1.4.  PRICE SUMMARY

  END-USE CONSUMPTION TABLES
      TABLE H.4.3.  INDUSTRIAL SECTOR ENERGY CONSUMPTION

  ELECTRIC UTILITY TABLES
      TABLE H.5.1.  ELECTRIC UTILITY FUEL PRICES AND CONSUMPTION
      TABLE H.5.2.  END-USE ELECTRICITY PRICES AND CONSUMPTION
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TABLE H.1.1. YEARLY SUPPLY AND DISPOSITION OF TOTAL ENERGY
CASE H: LOW INDUSTRIAL ELECTRICITY DEMAND
(QUADRILLION BTU PER YEAR)

	1975	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
SUPPLY												
PRODUCTION												
PETROLEUM..........	20.1	20.5	20.4	20.6	20.5	20.6	20.4	20.5	20.5	20.5	20.2	19.3
NATURAL GAS.........	19.6	20.1	19.9	18.2	17.5	17.1	15.3	14.8	14.8	15.5	16.8	16.5
COAL................	15.2	19.2	19.1	19.1	19.4	19.3	20.1	20.6	21.1	21.7	22.5	23.5
NUCLEAR.............	1.9	2.7	2.9	3.0	3.2	3.7	4.1	4.7	5.3	5.8	6.1	6.3
HYDRO/GEO/OTHER....	3.2	3.0	2.9	3.3	3.2	3.1	3.1	3.1	3.2	3.2	3.2	3.2
SUBTOTAL..........	60.1	65.5	65.2	64.2	63.7	63.8	63.1	63.7	64.8	66.6	68.8	68.9
NET IMPORTS												
CRUDE OIL..........	8.7	10.6	8.8	6.8	7.5	10.5	13.1	12.8	12.1	11.6	11.3	12.1
OTHER PETROLEUM....	3.8	2.9	2.6	2.1	2.5	3.0	3.1	3.1	3.1	3.1	3.0	3.1
NG (CONTRACTED)(1).	0.9	1.0	.9	.9	1.1	1.2	1.2	1.2	1.2	1.2	1.2	1.2
OTHER GAS(2).......	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.3	0.0	0.0	0.0
COAL AND COKE......	-1.7	-2.4	-2.9	-2.8	-2.6	-2.7	-2.9	-3.0	-3.2	-3.4	-3.6	-3.8
ELECTRICITY........	0.1	.2	.2	.2	.2	0.3	0.3	0.3	0.3	0.3	0.4	0.4
SUBTOTAL..........	11.7	12.3	9.6	7.3	8.6	12.3	14.9	14.8	13.9	12.9	12.3	13.0
SPR ADDITIONS(3)....	0.0	-.1	-.7	-.4	-.4	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3
STOCK WITHDRAWALS...	-1.1	-1.8	0.0	-.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL SUPPLY.........	70.7	75.9	74.1	70.9	71.9	75.8	77.6	78.2	78.4	79.1	80.0	81.6
CONSUMPTION												
NON-ELEC UTILITY FUEL												
PETROLEUM..........	29.5	31.5	29.9	28.6	29.2	30.8	32.3	32.1	31.5	30.9	30.6	30.7
NATURAL GAS(4).....	16.7	16.6	16.1	15.0	14.9	14.6	13.9	13.8	13.8	14.0	14.3	14.6
COAL................	4.0	3.4	3.4	3.0	2.9	3.2	3.3	3.4	3.5	3.6	3.7	3.8
SUBTOTAL..........	50.2	51.4	49.4	46.4	47.0	48.6	49.4	49.2	48.7	48.6	48.6	49.1
ELECTRIC UTILITY FUEL												
PETROLEUM..........	3.2	2.7	2.2	1.8	1.5	2.9	4.0	4.0	4.0	4.0	3.8	3.7
NATURAL GAS.........	3.2	3.8	3.8	3.3	3.4	2.7	1.6	1.6	1.6	1.6	1.9	2.1
COAL................	8.8	12.1	12.7	12.7	13.2	13.5	14.0	14.2	14.4	14.7	15.2	15.8
NUCLEAR.............	1.9	2.7	2.9	3.0	3.2	3.7	4.1	4.7	5.3	5.8	6.1	6.3
HYDRO/GEO/OTHER(5).	3.4	3.2	3.1	3.5	3.4	3.4	3.5	3.5	3.5	3.5	3.5	3.6
SUBTOTAL..........	20.5	24.5	24.7	24.3	24.7	25.8	26.8	27.7	28.4	29.3	30.2	31.2
TOTAL CONSUMPTION....	70.7	75.9	74.1	70.7	71.7	74.4	76.3	76.8	77.1	77.9	78.8	80.3
ADJUSTMENTS												
REFINERY LOSSES(6).	0.0	0.0	0.0	0.0	-0.1	0.0	0.2	0.2	0.2	0.2	0.2	0.3
DISCREPANCY(7).....	0.0	0.0	0.0	0.2	0.3	1.4	1.1	1.2	1.1	1.0	1.0	1.0
TOTAL DISPOSITION....	70.7	75.9	74.1	70.9	71.9	75.8	77.6	78.2	78.4	79.1	80.0	81.6

NOTE: THE "ANNUAL ENERGY REVIEW" FOR 1982 WILL CONTAIN LATER REVISIONS TO HISTORICAL DATA FOR 1975, 1980 AND 1982.
NOTE: TOTALS MAY NOT EQUAL SUM OF COMPONENTS DUE TO INDEPENDENT ROUNDING. FOR TABLE FOOTNOTES AND SOURCES SEE PAGE 219.

TABLE H.1.2. SUPPLY/DEMAND BALANCE
CASE H: LOW INDUSTRIAL ELECTRICITY DEMAND
(QUADRILLION BTU PER YEAR)

	1975	1980	1985	1986	1987	1988	1989	1990
DOMESTIC SUPPLY								
COAL..................	15.2	19.2	20.1	20.6	21.1	21.7	22.5	23.5
NATURAL GAS...........	19.6	19.9	15.3	14.8	14.8	15.5	16.0	16.5
PETROLEUM.............	20.1	20.5	20.4	20.5	20.5	20.5	20.2	19.3
NUCLEAR...............	1.9	2.7	4.1	4.7	5.3	5.8	6.1	6.3
OTHER(1)..............	3.2	3.0	3.1	3.1	3.2	3.2	3.2	3.2
TOTAL DOMESTIC SUPPLY..................	60.0	65.3	63.1	63.7	64.8	66.6	68.0	68.9
NATURAL GAS IMPORTS...	0.9	1.0	1.2	1.2	1.2	1.2	1.2	1.2
SUPPLEMENTAL GAS(2)...	0.0	0.2	0.0	0.3	0.3	0.0	0.0	0.0
PETROLEUM IMPORTS.....	12.5	13.5	16.2	15.9	15.2	14.6	14.3	15.2
TOTAL SUPPLY(3).........	73.4	80.0	80.5	81.1	81.5	82.4	83.5	85.3
DISPOSITION								
RESIDENTIAL...........	9.6	9.3	9.2	9.2	9.2	9.2	9.2	9.3
COMMERCIAL............	5.5	5.9	6.6	6.7	6.8	6.8	6.8	6.9
INDUSTRIAL(4).........	21.3	23.0	22.5	22.8	23.0	23.4	23.9	24.7
TRANSPORTATION........	17.7	19.7	18.6	18.2	17.7	17.3	17.0	16.9
TOTAL END-USE CONSUMPTION.............	54.1	57.9	56.9	56.9	56.7	56.7	57.0	57.7
DISCREPANCY.............	0.2	-0.1	-0.1	-0.2	-0.3	-0.4	-0.5	-0.4
ADJUSTMENTS.............	19.1	22.2	23.7	24.4	25.1	26.1	27.0	28.0
UTILITY GENERATION....	13.7	16.5	18.0	18.6	19.0	19.7	20.2	20.9
UTILITY TRANSMISSION..	0.6	0.7	0.8	0.9	0.9	0.9	1.0	1.0
REFINERY(5)...........	0.0	0.0	0.2	0.2	0.2	0.2	0.2	0.3
GAS PIPELINE(6).......	0.6	0.6	1.1	1.1	1.1	1.1	1.1	1.1
LEASE/PLANT FUEL(7)...	1.4	1.0	1.1	1.1	1.1	1.2	1.2	1.2
COAL EXPORTS..........	1.7	2.4	2.9	3.0	3.2	3.4	3.6	3.8
SPR ADDITIONS.........	0.0	0.1	0.3	0.3	0.3	0.3	0.3	0.3
STOCK WITHDRAWALS.....	1.1	1.8	0.0	0.0	0.0	0.0	0.0	0.0
RECLASSIFIED....... ..	0.0	-0.9	-0.7	-0.7	-0.7	-0.7	-0.6	-0.6
ADJUSTED CONSUMPTION....	73.4	80.0	80.5	81.1	81.5	82.4	83.5	85.3
ELECTRIC UTILITY FUEL								
COAL..................	8.8	12.1	14.0	14.2	14.4	14.7	15.2	15.8
PETROLEUM.............	3.2	2.7	4.0	4.0	4.0	4.0	3.8	3.7
NATURAL GAS...........	3.2	3.8	1.6	1.6	1.6	1.6	1.9	2.1
TOTAL FOSSIL............	15.2	18.6	19.6	19.8	20.0	20.4	20.9	21.7
NUCLEAR...............	1.9	2.7	4.1	4.7	5.3	5.8	6.1	6.3
OTHER.................	3.2	3.0	3.1	3.1	3.2	3.2	3.2	3.2
TOTAL...................	20.3	24.3	26.8	27.7	28.4	29.3	30.2	31.2
GENERATION..............	6.6	7.8	8.8	9.1	9.3	9.6	9.9	10.3

NOTE: TOTALS MAY NOT EQUAL SUM OF COMPONENTS DUE TO INDEPENDENT ROUNDING. FOR TABLE FOOTNOTES AND SOURCES SEE PAGE 219.

TABLE H.1.3. CONSUMPTION SUMMARY
CASE H: LOW INDUSTRIAL ELECTRICITY DEMAND
(QUADRILLION BTU PER YEAR)

	1975	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
RESIDENTIAL	9.571	9.335	9.104	9.236	9.143	9.173	9.204	9.228	9.234	9.233	9.244	9.264
STEAM COAL..............	0.091	0.065	0.080	0.082	0.071	0.078	0.076	0.074	0.073	0.071	0.069	0.068
NATURAL GAS............	5.022	4.866	4.654	4.793	4.710	4.649	4.582	4.520	4.460	4.407	4.368	4.338
DISTILLATE(1)...........	1.923	1.417	1.375	1.303	1.230	1.308	1.328	1.336	1.333	1.319	1.303	1.286
LIQUID PETROLEUM GAS...	0.528	0.539	0.536	0.570	0.590	0.565	0.576	0.582	0.583	0.579	0.575	0.570
ELECTRICITY	2.007	2.448	2.459	2.488	2.530	2.574	2.642	2.715	2.786	2.857	2.929	3.002
COMMERCIAL	5.513	5.892	5.818	5.867	6.182	6.437	6.599	6.707	6.758	6.773	6.813	6.862
STEAM COAL..............	0.135	0.095	0.107	0.122	0.086	0.097	0.095	0.092	0.090	0.087	0.085	0.082
NATURAL GAS............	2.559	2.674	2.580	2.683	2.720	2.730	2.720	2.689	2.640	2.582	2.536	2.493
DISTILLATE(1)...........	0.622	0.556	0.540	0.511	0.670	0.738	0.775	0.801	0.815	0.820	0.825	0.828
LO-SULFUR RESIDUAL......	0.506	0.566	0.470	0.376	0.490	0.542	0.569	0.588	0.598	0.602	0.605	0.608
LIQUID PETROLEUM GAS...	0.093	0.095	0.095	0.101	0.090	0.080	0.078	0.076	0.074	0.072	0.070	0.068
ELECTRICITY	1.598	1.907	2.026	2.074	2.150	2.251	2.362	2.460	2.540	2.610	2.693	2.783
INDUSTRIAL(2)	18.503	20.185	19.513	16.876	17.365	19.000	19.889	20.225	20.467	20.996	21.463	22.256
STEAM COAL..............	1.619	1.388	1.570	1.626	1.501	1.771	1.811	1.877	1.970	2.082	2.203	2.321
METALLURGICAL COAL......	2.178	1.793	1.647	1.057	1.132	1.262	1.303	1.325	1.338	1.354	1.360	1.376
NATURAL GAS............	6.133	6.497	6.639	5.414	5.348	5.406	5.082	5.103	5.216	5.508	5.751	6.054
DISTILLATE..............	1.272	1.569	1.285	1.212	1.348	1.789	2.347	2.392	2.314	2.233	2.150	2.146
LO-SULFUR RESIDUAL......	0.428	0.554	0.423	0.368	0.390	0.491	0.569	0.582	0.580	0.582	0.577	0.596
HI-SULFUR RESIDUAL......	0.856	0.713	0.531	0.483	0.530	0.718	0.881	0.909	0.909	0.905	0.896	0.919
LIQUID PETROLEUM GAS...	0.252	0.308	0.323	0.332	0.370	0.371	0.405	0.386	0.341	0.294	0.244	0.207
PET-CHEM FEEDSTOCK(3)..	1.519	2.401	2.111	1.862	1.980	2.175	2.290	2.374	2.454	2.559	2.675	2.839
OTHER(4)................	1.900	2.180	2.166	1.977	2.240	2.207	2.259	2.254	2.241	2.240	2.258	2.288
ELECTRICITY	2.346	2.781	2.817	2.545	2.620	2.810	2.941	3.024	3.104	3.240	3.349	3.509
TRANSPORTATION(5)	17.725	19.655	18.715	18.129	17.910	18.539	18.611	18.192	17.704	17.273	17.043	16.948
DISTILLATE..............	2.069	2.782	2.738	2.582	2.510	2.781	2.893	2.965	3.040	3.113	3.203	3.314
HI-SULFUR RESIDUAL......	0.731	1.401	1.163	0.930	0.900	1.012	1.254	1.079	1.103	1.122	1.149	1.182
GASOLINE(6).............	12.868	13.253	12.688	12.528	12.180	12.472	12.291	11.715	11.085	10.527	10.133	9.837
JET FUEL(7).............	2.029	2.179	2.087	2.049	2.280	2.234	2.332	2.392	2.436	2.470	2.518	2.575
LIQUID PETROLEUM GAS...	0.016	0.014	0.014	0.015	0.020	0.015	0.015	0.015	0.015	0.015	0.015	0.015
OTHER....................	0.000	0.014	0.014	0.014	0.010	0.014	0.014	0.014	0.014	0.014	0.014	0.014
ELECTRICITY	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010
ELECTRIC UTILITY FUEL	20.360	24.243	24.462	24.203	24.480	25.824	26.847	27.656	28.389	29.305	30.155	31.204
STEAM COAL..............	8.790	12.122	12.707	12.697	13.190	13.473	13.988	14.230	14.424	14.736	15.189	15.836
NATURAL GAS............	3.240	3.887	3.764	3.336	3.440	2.673	1.615	1.586	1.601	1.649	1.914	2.099
DISTILLATE(8)...........	0.350	0.121	0.077	0.048	0.090	0.178	0.312	0.316	0.272	0.266	0.292	0.348
LO-SULFUR RESIDUAL(9)..	2.860	1.611	1.251	0.988	0.780	1.778	2.532	2.557	2.557	2.567	2.350	2.254
HI-SULFUR RESIDUAL......	NA	0.922	0.898	0.789	0.600	0.936	1.150	1.139	1.131	1.137	1.117	1.133
HYDRO/GEO/OTHER(10).....	3.220	2.988	2.864	3.340	3.190	3.115	3.133	3.149	3.152	3.168	3.179	3.203
NUCLEAR.................	1.900	2.672	2.901	3.013	3.190	3.671	4.118	4.678	5.253	5.782	6.114	6.331
REFINERY FUEL(11)	2.769	2.787	2.304	2.198	2.480	2.360	2.571	2.557	2.503	2.452	2.403	2.394
NATURAL GAS............	0.975	0.846	0.668	0.574	0.720	0.433	0.287	0.277	0.285	0.318	0.348	0.379
DISTILLATE..............	0.035	0.018	0.011	0.011	0.010	0.012	0.013	0.013	0.012	0.012	0.012	0.012
LO-SULFUR RESIDUAL......	NA	NA	NA	NA	0.090	0.120	0.154	0.153	0.145	0.134	0.124	0.120
HI-SULFUR RESIDUAL......	0.269	0.213	0.167	0.137	0.200	0.299	0.487	0.493	0.474	0.433	0.395	0.365
LIQUID PETROLEUM GAS...	0.050	0.043	0.024	0.038	0.030	0.026	0.028	0.028	0.027	0.027	0.026	0.026
OTHER(12)...............	0.390	0.436	0.359	0.348	0.360	0.366	0.399	0.397	0.388	0.380	0.373	0.371
STILL GAS...............	1.050	1.231	1.073	1.085	1.080	1.105	1.203	1.197	1.172	1.148	1.125	1.121

NOTE: TOTALS MAY NOT EQUAL SUM OF COMPONENTS DUE TO INDEPENDENT ROUNDING. FOR TABLE FOOTNOTES AND SOURCES SEE PAGE 219.

TABLE H.1.4. PRICE SUMMARY
CASE H: LOW INDUSTRIAL ELECTRICITY DEMAND
(1982 DOLLARS PER MILLION BTU)

	1975	1980	1985	1986	1987	1988	1989	1990
WORLD OIL PRICE..........	20.70	39.32	25.47	28.24	31.53	34.11	35.68	36.71
RESIDENTIAL	5.95	8.33	9.58	10.28	10.95	11.34	11.51	11.74
NATURAL GAS............	2.75	4.16	6.75	7.48	8.08	8.39	8.41	8.59
DISTILLATE(1)..........	4.75	8.59	6.27	6.94	7.72	8.36	8.75	9.02
LIQUID PETROLEUM GAS..	4.11	6.67	6.07	6.68	7.38	7.93	8.23	8.51
ELECTRICITY	15.61	16.78	17.13	17.59	18.06	18.18	18.21	18.28
COMMERCIAL	6.27	8.38	10.12	10.83	11.52	11.94	12.17	12.45
NATURAL GAS............	2.17	3.84	6.51	7.28	7.91	8.25	8.33	8.54
DISTILLATE(1)..........	4.30	8.06	5.94	6.57	7.32	7.92	8.29	8.55
LO-SULFUR RESIDUAL....	4.13	5.32	4.79	5.31	5.92	6.45	6.77	7.88
LIQUID PETROLEUM GAS..	NA	6.67	6.08	6.70	7.39	7.95	8.25	8.53
ELECTRICITY	15.55	17.21	17.37	17.87	18.38	18.55	18.60	18.68
INDUSTRIAL(2)	3.37	5.44	6.41	6.94	7.48	7.81	7.98	8.15
STEAM COAL.............	1.81	1.55	2.10	2.13	2.16	2.20	2.25	2.33
METALLURGICAL COAL....	2.80	2.51	2.56	2.59	2.61	2.63	2.66	2.71
NATURAL GAS............	1.49	2.90	5.72	6.49	7.06	7.25	7.24	7.30
DISTILLATE.............	4.24	7.99	5.85	6.47	7.21	7.81	8.18	8.43
LO-SULFUR RESIDUAL....	4.11	5.14	4.71	5.22	5.82	4.34	6.66	6.97
HI-SULFUR RESIDUAL....	2.93	NA	4.19	4.72	5.34	5.87	6.20	6.51
LIQUID PETROLEUM GAS..	3.83	6.34	5.86	6.45	7.12	7.65	7.93	8.20
PET-CHEM FEEDSTOCK(3).	NA	7.88	6.72	7.41	8.25	8.93	9.35	9.63
OTHER(4)...............	NA	NA	5.18	5.71	6.35	4.88	7.21	7.45
ELECTRICITY	9.42	11.67	14.17	14.58	15.01	15.14	15.20	15.30
TRANSPORTATION(5)	6.72	9.91	7.75	8.43	9.21	9.78	10.07	10.21
DISTILLATE.............	5.85	8.39	6.21	6.87	7.64	8.30	8.69	8.96
HI-SULFUR RESIDUAL....	2.93	3.97	3.65	4.13	4.68	5.17	5.47	5.76
GASOLINE(6)............	7.57	11.32	8.69	9.47	10.35	10.97	11.29	11.41
JET FUEL(7)............	3.69	7.51	6.60	7.24	8.05	8.69	9.08	9.34
LIQUID PETROLEUM GAS..	NA	NA	5.81	6.40	7.08	7.62	7.91	8.18
ELECTRICITY	NA	NA	16.74	17.25	17.78	17.98	18.05	18.10
ELECTRIC UTILITY FUEL	2.04	1.84	2.05	2.15	2.24	2.30	2.34	2.41
STEAM COAL.............	1.58	1.71	1.73	1.75	1.77	1.78	1.80	1.85
NATURAL GAS............	1.14	2.80	5.65	6.47	7.06	7.13	7.17	7.23
DISTILLATE(8)..........	3.28	7.22	5.87	6.50	7.25	7.85	8.21	8.47
LO-SULFUR RESIDUAL(9).	3.27	5.90	4.78	5.31	5.93	6.46	6.73	7.00
HI-SULFUR RESIDUAL....	NA	4.55	3.68	4.15	4.70	5.18	5.48	5.76
NUCLEAR................	NA	.85	0.85	0.85	0.85	0.85	0.85	0.85
REFINERY FUEL	NA	NA	2.31	2.59	2.91	3.16	3.29	3.41
NATURAL GAS............	NA	3.08	4.85	5.54	6.12	6.32	6.30	6.31
DISTILLATE.............	NA	6.09	5.14	5.70	6.37	6.90	7.24	7.47
LO-SULFUR RESIDUAL....	NA	NA	4.13	4.59	5.13	5.60	5.90	6.18
HI-SULFUR RESIDUAL....	NA	4.89	3.47	3.93	4.47	4.95	5.24	5.53
LIQUID PETROLEUM GAS..	NA	NA	5.16	5.70	6.31	6.79	7.05	7.31
OTHER(10)..............	NA	NA	5.07	5.60	6.24	6.77	7.10	7.34

NOTE: TOTALS MAY NOT EQUAL SUM OF COMPONENTS DUE TO INDEPENDENT ROUNDING. FOR TABLE FOOTNOTES AND SOURCES SEE PAGE 219.

TABLE H.4.3. INDUSTRIAL SECTOR ENERGY CONSUMPTION
CASE H: LOW INDUSTRIAL ELECTRICITY DEMAND
(TRILLIONS OF BTU PER YEAR)

	1980	1985	1986	1987	1988	1989	1990
COAL......................	1387.88	1811.09	1877.20	1969.59	2082.33	2202.86	2321.49
NATURAL GAS..............	6497.36	5081.96	5102.78	5215.94	5508.01	5751.31	6049.48
(RAW MATERIALS(1).....	650.77	486.53	475.06	470.38	475.56	486.82	493.30)
DISTILLATE...............	1560.70	2347.47	2391.57	2313.52	2232.71	2149.95	2146.17
HI-SULFUR RESIDUAL.......	713.20	881.31	908.62	909.42	905.34	895.67	919.05
LO-SULFUR RESIDUAL.......	553.58	569.32	581.70	580.44	581.82	576.93	596.11
ELECTRICITY..............	2781.00	2941.40	3024.23	3103.54	3240.47	3348.70	3509.19
LIQUID PETROLEUM GAS....	307.89	404.88	385.96	341.43	293.87	244.49	286.56
PET-CHEM FEEDSTOCKS(2)..	2401.48	2289.86	2374.27	2454.12	2558.74	2675.40	2837.12
METALLURGICAL COAL.......	1793.34	1302.59	1325.37	1337.65	1353.56	1359.74	1375.68
OTHER(3)..................	2100.32	2258.77	2253.63	2241.04	2239.57	2257.81	2289.04
TOTAL ENERGY.............	20184.73	19888.64	20225.32	20466.67	20996.42	21462.84	22249.87

(1) NATURAL GAS CONSUMED AS A FEEDSTOCK BY THE CHEMICAL INDUSTRY (ALREADY INCLUDED IN THE NATURAL GAS TOTAL).

(2) CONSISTS OF STILL GAS USED FOR FEEDSTOCK PUROPSES, NAPTHAS LESS THAN 400 DEGREES, OTHER FUELS GREATER THAN 400 DEGREES, AND LIQUID PETROLEUM GASES USED FOR GAS UTILITY FUEL AND FOR CHEMICAL FEEDSTOCKS.

(3) ASPHALT, PETROLEUM COKE, LUBRICANTS, INDUSTRIAL KEROSENE, WAXES AND MISCELLANEOUS PETROLEUM PRODUCTS.

NOTE: INDUSTRIAL SECTOR TOTAL DIFFER FROM THOSE SHOWN IN THE "MONTHLY ENERGY REVIEW" BY EXCLUDING ELECTRICITY LOSSES, GASOLINE, NATURAL GAS USED AS A LEASE AND PLANT FUEL, AND ALL REFINERY FUELS EXCEPT COAL AND ELECTRICITY, AND BY INCLUDING LUBRICANTS CONSUMED BY THE TRANSPORTATION SECTOR. IN 1980 ONLY, THE RESIDUAL AND DISTILLATE DETAIL HAS BEEN CONVERTED TO THE NEW BASIS FOR CONSISTENCY WITH THE PETROLEUM BALANCE TABLE AND WITH 1980 FUEL DETAIL USED IN THE "SHORT-TERM ENERGY OUTLOOK."

NOTE: ENTRIES FOR 1980 ARE HISTORICAL DATA.

SOURCES: ON PAGE 222, SEE 1, PAGE 17; 15, PAGE 11, TABLE 5; AND 15, PAGE 127, TABLE 55.

TABLE H.5.1. ELECTRIC UTILITY FUEL PRICES AND CONSUMPTION
CASE H: LOW INDUSTRIAL ELECTRICITY DEMAND
(1982 DOLLARS PER MILLION BTU; TRILLIONS OF BTU PER YEAR)

YEARS	COAL	NATURAL GAS	DISTILLATE	LO-S RESID	HI-S RESID	FOSSIL FUEL	NUCLEAR	HYDRO	ALL FUELS
FUEL PRICES									
1980	1.71	2.80	7.22	5.90	4.55	NA	NA	--	NA
1985	1.74	5.65	5.87	4.78	3.68	2.63	0.85	--	2.05
1986	1.75	6.47	6.50	5.31	4.15	2.80	0.85	--	2.15
1987	1.77	7.06	7.24	5.93	4.70	2.96	0.85	--	2.24
1988	1.78	7.13	7.85	6.46	5.18	3.08	0.85	--	2.30
1989	1.80	7.17	8.21	6.73	5.47	3.14	0.85	--	2.34
1990	1.85	7.23	8.47	7.00	5.76	3.22	0.85	--	2.41
FUEL CONSUMPTION									
1980	12122.	3807.	121.	1611.	922.	18583.	2672.	2988.	24243.
1985	13988.	1615.	312.	2532.	1150.	19596.	4118.	3133.	26847.
1986	14259.	1586.	316.	2557.	1139.	19829.	4678.	3149.	27656.
1987	14424.	1601.	272.	2557.	1131.	19984.	5253.	3152.	28389.
1988	14736.	1649.	266.	2547.	1137.	20355.	5782.	3168.	29305.
1989	15189.	1914.	292.	2350.	1117.	20862.	6114.	3179.	30155.
1990	15836.	2099.	348.	2254.	1133.	21671.	6331.	3203.	31204.

NA=NOT AVAILABLE.
--=NOT APPLICABLE.
NOTE: ENTRIES FOR 1980 ARE HISTORICAL DATA.
SOURCES: ON PAGE 222. SEE 1; 2, PP 160-170, TABLES B1, B2, B3, AND B4; 2. PP 253-255. TABLE C9; 2. PP 262-263. TABLE C13; 2. PP 270-271. TABLE C17; AND 2. PP 290-291. TABLE C27.

TABLE H.5.2. END-USE ELECTRICITY PRICES AND CONSUMPTION
CASE H: LOW INDUSTRIAL ELECTRICITY DEMAND
(1982 MILLS PER KWH; BILLION KWH PER YEAR)

YEARS	RESIDENTIAL	COMMERCIAL	TRANSPORTATION	INDUSTRIAL	AVG./TOTAL
END-USE PRICES					
1980	57.25	58.72	NA	39.82	50.82
1985	58.43	59.25	57.11	48.34	54.94
1986	60.02	60.98	58.07	49.74	56.52
1987	61.61	62.72	60.67	51.22	58.12
1988	62.02	63.30	61.36	51.66	58.55
1989	62.13	63.44	61.59	51.86	58.70
1990	62.39	63.75	61.77	52.22	58.95
END-USE CONSUMPTION					
1980	717.50	558.91	0.00	815.06	2091.47
1985	774.23	692.42	3.05	862.12	2331.82
1986	795.89	721.04	3.05	886.40	2406.38
1987	816.38	744.56	3.05	929.65	2473.83
1988	837.30	764.85	3.05	949.78	2554.97
1989	858.49	789.26	3.05	981.50	2632.30
1990	879.83	815.71	3.05	1028.55	2727.13

NA=NOT AVAILABLE.
NOTE: ENTRIES FOR 1980 ARE HISTORICAL DATA.
SOURCES: ON PAGE 222. SEE 1. PP 15-18; AND 2. PP 229-40. TABLES C1. C2. C3. AND C4.

Endnotes to Table 1.1:

(1) Includes both pipeline natural gas and liquified natural gas.
(2) Includes increased gas or oil imports in the forecast years 1984-1990.
(3) Indicates strategic petroleum reserve fill rate additions (listed as negative in the table). Stock withdrawals is a balancing item.
(4) Nonutility consumption of natural gas includes lease and plant fuel and transportation use.
(5) Includes net imports of electricity.
(6) Refinery loss indicates cracking losses.
(7) Discrepancy indicates differences in independent estimates of supply and demand components.

Note: Totals may not equal components due to independent rounding.
Note: Other includes wood waste consumed by electric utilities.
Note: Industrial hydroelectric power is excluded from the supply and disposition balances.
Note: Entries for 1975, 1980, 1981, and 1982 are historical data taken from reference 21. Entries for 1983 are projected from the Short-Term Integrated Forecasting System, February 1983 base case.
Sources: On page 222, see 1; 4; 12; 14; and 21.

Endnotes to Table 1.2:

(1) Includes hydroelectric power, geothermal power, and wood waste consumed by electric utilities.
(2) Includes increased gas or oil imports.
(3) Total supply differs from that shown on Table A.1.1 by the exclusion of coal and electricity net imports and stock withdrawals.
(4) Includes refinery fuel use.
(5) Indicates cracking losses during the refining process.
(6) Indicates gas used to fuel compressors in the pipeline machinery.
(7) Represents gas used as a fuel in field gathering and plant processing machinery.

NA=Not Available.

Note: Totals may not equal to components due to independent rounding.
Note: Discrepancy is supply less consumption less adjustments.
Note: Entries for 1975 and 1980 are historical data.
Sources: On page 222, see 1; and 2.

Endnotes to Table 1.3:

(1) In the residential and commercial sectors, distillate also includes kerosene.

(2) Industrial fuel totals exclude refinery fuel consumption and lease and plant fuel consumption.

(3) Petrochemical feedstocks consists of still gas used for feedstock purposes, naphthas less than 400 degrees, other oils greater than 400 degrees, and liquid petroleum gases used for gas utility fuel and for chemical feedstocks.

(4) Consists of special naphthas, miscellaneous petroleum products, industrial kerosene, lubricants, waxes, unfractionated steam, plant condensate, natural gasoline, asphalt, road oil, nonrefinery and nonfeedstock consumption of still gas, and petroleum coke excluding refinery and electrical utility product supplied.

(5) Transportation fuel totals exclude lubricants and natural gas used as a pipeline fuel.

(6) Includes aviation gasoline and motor gasoline reported as being consumed by the commercial and industrial sectors.

(7) Includes naphtha and kerosene type jet fuel.

(8) The 1975 entry includes small amounts of kerosene consumed by electric utilities.

(9) The 1975 entry includes small amounts of petroleum coke consumed by electric utilities.

(10) Other consists of wood wastes.

(11) Excludes coal, purchased steam, electricity, and crude petroleum used as a fuel.

(12) Consists of petroleum coke and the fuel category labeled "other" on the refinery fuel consumption table in the Petroleum Statement Annual.

NA=Not Available.

Note: Entries for 1975 and 1980 are historical data, however data for 1980 are transformed to new basis petroleum totals. Entries for 1981, 1982 and 1983 are projected from the Short-Term Integrated Forecasting System and IFFS. They may contain inconsistencies with Table 1.1 because of the additional detail and the inclusion of reclassified.

Sources: On page 222, see 1; 3, page 23, Table 25; 4, page 27, Table 21; and 5, Table 19.

Endnotes to Table 1.4:

(1) In the residential and commercial sectors, distillate also includes kerosene.

(2) Industrial fuel totals exclude refinery fuel consumption and lease and plant fuel consumption.

(3) Petrochemical feedstocks consists of still gas used for feedstock purposes, naphthas less than 400 degrees, other fuels greater than 400 degrees, and liquid petroleum cases used for gas utility fuel and for chemical feedstocks.

(4) Consists of special naphthas, miscellaneous petroleum products, industrial kerosene, lubricants, waxes, unfractionated steam, plant condensate, natural gasoline, asphalt, road oil, nonrefinery and nonfeedstock consumption of still gas, and petroleum coke excluding refinery and electrical utility product supplied.

(5) Transportation fuel totals exclude lubricants and natural gas used as a pipeline fuel.

(6) Includes aviation gasoline and motor gasoline reported as being consumed by the commercial and industrial sectors.

(7) Includes naphtha and kerosene type jet fuel.

(8) The 1975 entry includes small amounts of kerosene consumed by electric utilities.

(9) The 1975 entry includes small amounts of petroleum coke consumed by electric utilities.

(10) Consists of petroleum coke and the fuel category labeled "other" on the refinery fuel consumption table in the Petroleum Statement Annual.

NA=Not Available.

Note: Entries for 1975 and 1980 are historical data.

Sources: On page 222, see 6; 7, pp 28-29, Table 2; and 8, pp 16-17, Table 3.

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Appendix B
Sectoral Definitions and Fossil Fuel Terminology

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This appendix lists the sectoral definitions used in the Integrated Future Forecasting System (IFFS). These definitions provide an explanation of the conceptual differences between end-use sector fuel totals in this report and in other Energy Information Administration reports. The sector definitions are followed by a glossary of terms, organized by fossil fuels, which are used in the main body of the report and in the appendix tables, is then provided. The fossil fuel glossary is followed by an explanation of the thermal conversion factors used in IFFS.

Sectoral Definitions

Residential Sector: Energy consumed by private household establishments primarily for space heating, water heating, air conditioning, cooking, and clothes drying. This sector's consumption does not include consumption by individual households which are located in master metered apartment buildings.

Commercial Sector: Energy consumed by nonmanufacturing business establishments. Included are motels, restaurants, wholesale businesses, retail stores, laundries, and other service enterprises, as well as health, social, and educational institutions, and energy consumed by Federal, State and local government. This sector includes consumption by individual households which are located in master metered apartment buildings. The consumption of motor gasoline by this sector has been transferred to the transportation sector.

Industrial sector: Energy consumed by manufacturing, construction, mining, agriculture, fishing, and forestry establishments. Natural gas consumed as a lease and plant fuel, motor gasoline, jet fuel, industrial hydroelectric power and refinery fuel, except for electricity and coal, are excluded from this sector. Lubricants consumed by the industrial sector include transportation sector lubricants.

Transportation Sector: Energy consumed to move people and commodities in both private and public sectors included are military, railroad, vessel bunkering, and marine uses. Natural gas used as a pipeline fuel and lubricants are excluded from this sector.

Electric Utility Sector: Energy consumed by private and publicly owned establishments which generate electricity primarily for resale.

Refinery Sector: Fuels consumed by petroleum refineries for all purposes, except coal and electricity which are included in the industrial sector.

Coal Terminology

Anthracite - A hard, jet black coal with a high luster used for generating electricity and space heating. Its ignition temperature is about 900 degrees Fahrenheit. Anthracite is mined almost exclusively in northeastern Pennsylvania.

Bituminous Coal - The most common coal, also known as soft coal. It is dense, black, often with well-defined bands of bright and dull material, and is used for generating electricity, making coke, and space heating. The ignition temperature is 700 to 800 degrees Fahrenheit. Bituminous coal is mined chiefly in the Appalachian and interior coal fields.

Coal Producing Districts - A classification of coal fields defined in the Bituminous Coal Act of 1937. The districts were originally established to aid in formulating minimum prices of bituminous and subbituminous coal and lignite. Because much statistical information was compiled in terms of these districts, their use for statistical purposes has continued since the abandonment of that legislation in 1943.

Coal Producing Regions - A geographic classification of coal producing States. The States in the Appalachian regions are Alabama, Georgia, eastern Kentucky, Maryland, Ohio, Pennsylvania, Tennessee, Virginia, and West Virginia. The States in the Interior region are Arkansas, Illinois, Indiana, Iowa, Kansas, western Kentucky, Missouri, Oklahoma, and Texas. The States in the Western region are Alaska, Arizona, Colorado, Montana, New Mexico, North Dakota, Utah, Washington, and Wyoming.

Coal Rank/Group - A classification of coal based on fixed carbon, volatile matter, and heating value. It is an indication of the progressive alteration, or coalification, from lignite to anthracite.

F.O.B. Mine Price - The free on board mine price. This is the price paid for coal measured in dollars per short ton at the mining operation site and therefore does not include freight/shipping and insurance costs.

Lignite - A brownish black coal having a high moisture content and used mainly to generate electricity. It is mined in North Dakota, Montana, and Texas.

Subbituminous Coal - A type of coal having a dull black color. It is used for generating electricity and space heating and is mined in the western coal fields.

Blast Furnace - A furnace in which solid fuel (coke) is burned with an air blast to smelt iron ore.

Btu (British Thermal Unit) - A standard unit for measuring the quantity of heat energy equal to the quantity of heat required to raise the temperature of 1 pound of water by 1 degree Fahrenheit.

C.I.F. Cost - Cost including insurance and freight costs. The delivered cost of coal.

Coal Carbonized - The amount of coal that was decomposed into solid (coke and breeze), liquid, and gaseous products by heating it in a coke oven in a limited air supply or in the absence of air.

Coke - The strong porous residue consisting of carbon and mineral ash. It is formed when the volatile constituents of bitiminous coal are driven off by being heating in a limited air supply or in the absence of air. It is most often used as a fuel source in a blast furnace.

Coke Plants - Plants where coal is carbonized in slot or beehive ovens for the manufacture of coke.

F.A.S. Value - Free Alongside Ship value. This is the value of a commodity at the port of exportation. It generally includes the purchase price plus all charges incurred in placing the commodity alongside the carrier at the port of exportation in the country of exportation.

Short Ton - A unit of weight equal to 2,000 pounds.

Stocks - The supply of coal or coke at the mine, plant, or utility at the end of the quarter.

Natural Gas Terminology

Associated-dissolved Gas - Natural gas occurring in reservoirs with crude oil either as free gas (associated) or as gas in solution with the crude oil (dissolved).

Nonassociated Gas - Free natural gas not in contact with crude oil in the reservoir.

Proved Reserves - Geological deposits of gas known to exist and to be economically recoverable using current technology.

Interstate Gas - Natural gas that is dedicated to interstate commerce.

Intrastate Gas - Natural gas that is produced and consumed within one state's boundaries and transported by nonjurisdictional pipelines. As such, the gas was not subject to any Federal regulation until the enactment of the Natural Gas Policy Act of 1978.

Producer - That company or entity that drills, maintains, and operates the gas or gas/oil well. The producer may also perform the gathering and initial field handling and processing of the gas.

Pipeline - The company that receives the gas from the producer and transports it for delivery to either another pipeline, a local distribution company or to end-use consumers. The pipeline company generally purchases the gas from the producer after field handling of the gas or directly at the wellhead and resells it to a local distribution company. Whether or not the pipeline operates across State boundaries determines its classification as interstate or intrastate.

Natural Gas Policy Act of 1978 (NGPA) - Legislation providing: a broad range of price controls on domestically produced gas, with price regulations extended to gas that had not been regulated earlier; a schedule of price increases leading to decontrol at specified future dates; and a mechanism for shifting most of the burden for the higher cost, new gas supplies on industrial consumers who could potentially convert to coal.

Incremental Pricing - Those provisions of the NGPA written to pass the cost of higher priced gas to large industrial consumers. The industrial customers were required to pay the increased cost until their cost reached a level computed from the equivalent price of fuel oil. Due to the high number of exemptions granted, the incremental pricing provisions have had little impact on consumer prices.

Old Gas - Terminology used to encompass several of the NGPA categories, generally Section 103, 104, 105, 106, and 108 gas. This loosely defines old wells and reservoirs existing at the time of NGPA enactment.

New Gas - Terminology generally used to describe Section 102 gas or, less frequently, Section 102 and 107 gas.

High-Price Gas - Terminology used for expensive sources of gas, Section 107, most of which is either deregulated or benefits from relatively high ceiling prices.

Categories of gas - Natural gas as defined by the NGPA, designated by the section of the act in which they are defined:

Section 102 - New Natural Gas - New reservoir gas, new gas from both old and new offshore gas leases, and new onshore wells at least 2.5 miles from the nearest old well or 1,000 feet deeper than any well within 2.5 miles.

Section 103 - New Onshore Production Wells - Onshore wells with drilling started after February 19, 1977, but not qualifying as Section 102.

Section 104 - Gas Dedicated to Interstate Commerce before NGPA Enactment (November 9, 1978) - Including flowing gas and gas from certain designated locations.

Section 105 - Gas Under Existing Intrastate Contracts - Gas sold under such contracts in place at date of enactment.

Section 106 - Sales of Gas Made Under "Rollover" Contracts - Gas under contracts with rollover, price-renegotiation clauses.

Section 107 - High Cost Natural Gas - Gas from wells drilled after February 19, 1977, and 15,000 feet or deeper, gas from coal seams, Devonian shale, or tight sands, or from certain other high-cost sources.

Section 108 - Stripper Well Natural Gas - Nonassociated natural gas produced at low flow rates.

Section 109 - Other categories of natural gas - Largely Prudhoe Bay Alaskan gas, not projected to be a source be significant quantities through 1990.

Petroleum Terminology

Alcohol - The family name of a group of organic chemical compounds composed of carbon, hydrogen, and oxygen. The series of molecules vary in chain length and are composed of a hydrocarbon plus a hydroxyl group, CH-(CH)n-OH. "Alcohol" includes ethanol and methanol.

Asphalt - A dark-brown-to-black material, containing bitumens as the predominant constituents, obtained either naturally or by petroleum processing. It is the residue from the distillation of an asphaltic crude oil or the insoluble portion from an extraction process that utilizes propane or other suitable solvents. The definition includes crude asphalt as well as the following finished products: cements, fluxes, the asphalt content of emulsion (exclusive of water), and petroleum distillates blended with asphalt to make cutback asphalts. The conversion factor is 5.5 42-gallon barrels per short ton.

Aviation Gasoline (Finished) - All special grades of gasoline for use in aviation reciprocating engines, as given in ASTM Specification D 910 and Military Specification MIL-G-5572. "Aviation gasoline" includes all refinery products within the gasoline range that are to be marketed straight or in blends as aviation gasoline without further refinery processing.

Barrels - A volumetric unit of measure of crude oil and petroleum products equivalent to 42 U.S. gallons. This measure is used in most statistical reports. Factors for converting petroleum coke, asphalt, wax, and still gas to barrels are given in the definitions for these products.

Barrels Per Calendar Day - Represents the number of barrels per stream day of input to crude oil processing units that can be processed by a refinery in a average 24-hour period after making allowances for the following limitations: downstream limitations, environmental constraints, types and grades of input, planned and unplanned downtime, and types of grades of products.

Barrels Per Stream Day - Represents the amount a unit can process running at full capacity under optimal crude and product slate conditions.

Catalytic Cracking - Basically the same as thermal cracking since heat is used, but differs in its use of a catalyst to direct the cracking reaction to produce more of the higher octane hydrocarbons; provides a motor spirit of 10 to 15 octane numbers higher than that of the thermally cracked product and is more effective in producing isoparaffins and aromatics, all of which are of high anti-knock qualities or value. Modern cracking units are one of two types: the "fluid process" uses a finely powdered catalyst which is moved and circulated through the system by a "fluidized-solid" technique, and the other, "moving bed process," in which pellet catalysts are circulated by elevators or gas-lift method.

Catalytic Hydrocracking - A refining process for converting middle-boiling or residual material to high-octane gasoline, reformer charge stock, jet fuel, and/or high grade fuel oil. Hydrocracking is an efficient, relatively low-temperature process using hydrogen and catalyst.

Catalytic Hydrofining - A process for improving the quality of petroleum products, especially gasoline, by treating them with hydrogen in the presence of a catalyst, at a temperature below that at which decomposition occurs.

Catalytic Hydrotreating - A process of treating petroleum fractions and unfinished oils in the presence of catalysts and substantial quantities of hydrogen to upgrade their quality.

Catalytic Reforming - The use of controlled heat and pressure with catalysts to effect the rearrangement of certain hydrocarbon molecules without altering their composition appreciably; the conversion of low-octane gasoline fractions into higher octane stocks suitable for blending into finished gasoline; also the conversion of naphthas to obtain more volatile product of higher octane number.

Crude Distillation - The processing of separating crude oil components by heating and subsequent condensing of the fractions by cooling.

Crude Oil - A naturally occurring mixture of liquid hydrocarbons that remains liquid at atmospheric pressure after passing through surface separating facilities. Lease condensate is included. Drips are also included, but topped crude (residual) oil and other unfinished oils are excluded. Liquids produced at natural gas processing plants and mixed with crude oil are likewise excluded where identifiable.

Crude Oil Type

- Sweet - Under 0.5 wt. % sulfur
  Light Medium - 15% or less @ 1050°F. + residuum assay
  Heavy Medium - Greater than 15% @ 1050°F + residuum assay

- High Sulfur - in excess of 1.0 wt. % sulfur
  Light High - 15% or less @ 1050°F. + residuum assay
  Heavy High - Greater than 15% @ 1050°F. + residuum assay

- Domestic - Crude oil produced in the United States or from its outer continental shelf as defined in 43 U.S.C. 1331. Synthetic hydrocarbons such as shale oil and tar sand oil are included.

- Foreign - Crude oil produced outside the United States. Imported Athabasca hydrocarbons are reported as crude oil.

Distillate Fuel Oil - A general classification for one of the petroleum fractions which, when produced in conventional distillation operations, has a boiling range of 400 degrees Farenheit at the 10-percent point to 640 degrees Farenheit at the 90-percent point. It is used primarily for space heating, on- and off-highway diesel engine fuel (including railroad engine fuel and fuel for agricultural machinery), and electric power generation. Included are products known as No. 1 and No. 2 heating oils, diesel fuels, and No. 4 fuel oil.

Feedstocks - Crude oil or other hydrocarbons that are the basic materials for a refining or manufacturing process.

Field Production - Represents crude oil production on leases, natural gas liquids production at natural gas processing plants, and new supply of other hydrocarbons and alcohol.

Hydrogen - A colorless, highly flammable gaseous element, the lightest of all gases and the most abundant element in the universe, used in the production of synthetic ammonia and methanol, in petroleum refining, and in hydrogenation of organic materials.

Kerosene - A petroleum distillate that boils at a temperature between 300 and 550 degrees Farenheit, that has a flash point higher than 100 degrees Farenheit by ASTM Method D 56, that has a gravity range from 40 degrees to 46 degrees API, and that has a burning point in the range of 150 to 175 degrees Farenheit. It is a clean-burning product suitable for use as an illuminant when burned in wick lamps. Includes grades of kerosene called range oil having properties similar to No. 1 fuel oil, but with a gravity of about 43 degrees API and having a maximum end-point of 625 degrees Farenheit. Kerosene is used in space heaters, cook stoves, and water heaters.

Kerosene-Type Jet Fuel - A quality kerosene product with an average gravity of 40.7 degrees API, a 10-percent distillation temperature of 400 degrees Farenheit, and an endpoint of 572 degrees Farenheit. It is covered by ASTM Specification D 1655 and Military Specification MIL-T-5624L (Grade JP-5 and JP-8). It is used primarily for commercial turbojet and turboprop aircraft engines.

Lease Condensate - A natural gas liquid recovered from gas well gas (associated and nonassociated) in lease separators or natural gas field facilities. Lease condensate consists primarily of pentanes and heavier hydocarbons.

Lubricants - A substance used to reduce friction between bearing surfaces. Petroleum lubricants may be produced either from distillates or residues. Other substances may be added to impart or improve certain required properties. "Lubricants" includes all grades of lubricating oils from spindle oil to cylinder oil and those used in greases. The three categories reported are:

- Bright Stock - A refined, high viscosity lubricating oil base stock that is usually made from a residuum by a treatment such as deasphalting, acid treatment, or solvent extraction.

- Neutral - A distillate lubricating oil base stock with a viscosity that is usually not above 550 Saybolt Seconds Universal (SSU) at 100 degrees Farenheit. It is prepared by a treatment such a hydrofining, acid treatment, or solvent extraction.

- Other - A lubricating oil base stock used in finished lubricating oils and greases, including black, coastal, and red oils.

Miscellaneous Products - Includes all finished products not classified elsewhere. "Miscellaneous products" include petroleum, absorption oils, ram-jet fuel, petroleum rocket fuels, synthetic natural gas feedstocks, and naphthas.

Motor Gasoline (Finished) - A complex mixture of relatively volatile hydrocarbons, with or without small quantities of additives for use in spark-ignition engines. Specifications for motor gasoline, as given in ASTM Specification D 439 or Federal Specification VV-G-1690B, include a boiling range of 122 to 158 degrees Farenheit at the 10-percent point to 365 to 374 degrees Farenheit at the 90-percent point and a Reid vapor pressure range from 9 to 15 psi. "Motor gasoline" includes finished leaded gasoline, finished unleaded gasoline, and gasohol. Blendstock is excluded until blending has been completed. Alcohol that is to be used in the blending of gasohol is also excluded.

- Leaded Gasoline - Contains more than 0.05 grams of lead per gallon or more than 0.005 grams of phosphorus per gallon. The actual lead content of any given gallon, however, may vary as a function of the size of the producer and company according to specific Environmental Protection Agency waiver provisions. Premium and regular grades are included, depending on the octane rating.

- Unleaded Gasoline - Contains up to 0.05 grams of lead per gallon and 0.005 grams of phosphorus per gallon. Premium and regular grades are included, depending on the octane rating.

- Gasohol - A blend of alcohol and finished motor gasoline that is more than 90 percent of finished motor gasoline (leaded or unleaded are described above) and no less than 10 percent or more alcohol (ethanol or methanol).

Naphtha - A colorless flammable liquid, obtained from crude petroleum and used as a solvent and cleaning fluid and as a raw material for gasoline.

Naphtha-Type Jet Fuel - A fuel in the heavy naphtha boiling range with an average gravity of 52.8 percent API and 20 to 90 percent distillation temperatures of 290 to 470 degrees Farenheit, meeting Military Specification MIL-T-5624L (Grade JP-4). JP-4 is used for turbojet and turboprop aircraft engines, primarily by the military. This category excludes ram-jet and petroleum rocket fuels, which are included in the "Miscellaneous Products" category.

Natural Gas Plant Liquids - Natural gas liquids recovered from natural gas in gas processing plants and in some situations, from natural gas field facilities. Natural gas liquids extracted by fractionators are also included. These liquids are defined according to the published specifications of the Gas Processors Association and the American Society for Testing and Materials, and are classified as follows: ethane, propane, ethane-propane mix, isobutane, butane, butane-propane mix, isopentane, natural gasoline, plant condensate, unfractionated stream, and other products from natural gas processing plants (i.e., products meeting the standards of finished petroleum products produced at natural gas processing plants, such as finished motor gasoline, finished aviation gasoline, special naphthas, kerosene, distillate, fuel oil, and miscellaneous products).

Operable Capacity - Represents the status of processing units at a petroleum refinery. Operable capacity is the sum of operating and idle capacity.

- Operating capacity - Capacity that is in operation.
- Idle Capacity - Capacity not in operation but capable of being placed in operation within 90 days.

Permanently Shutdown - A classification for petroleum refineries which represents refineries which have ceased operation and/or are incapable of being placed in operation within 90 days.

Petroleum Products - Petroleum products obtained from the processing of crude oil (including lease condensate), natural gas, and other hydrocarbon compounds. Petroleum products include unfinished oils, natural gasoline and isopentane, plant condensate, unfractionated stream, ethane, liquefied petroleum gases, aviation gasoline, motor gasoline, naphtha-type jet fuel, kerosene-type jet fuel, kerosene, distillate fuel oil, residual fuel oil, naphtha-less than 400 degrees Farenheit end-point, other oils-over 400 degrees Farenheit end-point, special naphthas, lubricants, waxes, petroleum coke, asphalt, road oil, still gas, and miscellaneous products.

Petroleum Refinery - An installation that manufactures finished petroleum products from crude oil, unfinished oils, natural gas plant liquids, other hydrocarbons, and alcohol.

Primary Stocks - Stocks of crude oil or petroleum products held in storage by refineries, natural gas processing plants, pipelines, tankfarms, and bulk terminals. Crude oil that is in transit from Alaska or that is stored on Federal leases is included. Bulk terminals are facilities that can store at least 50,000 barrels of petroleum products or that can receive petroleum products by tanker, barge, or pipeline. "Primary Stocks" excludes stocks of foreign origin that are meant for domestic consumption but have not clear the United States Customs Service.

Residual Fuel Oil - Topped crude of refinery operations. "Residual Fuel Oil" includes No. 5 and No. 6 fuel oils as defined in ASTM, Specification D 396 and Federal Specification VV-F-815C; Navy Special fuel oil as defined in Military Specification MIL-F859E including Amendment 2; Bunker C fuel oil; and acid sludge used for refinery fuels. Residual fuel oil is used for the production of electric power, space heating, vessel bunkering, and various industrial purposes.

- Bunker C - A heavy residual fuel oil used by ships and industry and for heating large-scale installations; also referred to as No. 6 fuel oil.

Road Oil - Any heavy petroleum oil, including residual asphaltic oils, used as a dust palliative and surface treatment of roads and highways. It is generally produced in six grades, from 0, the most liquid, to 5, the most viscous.

Special Naphthas - All finished products within the gasoline range that are used as paint thinners, cleaners, and solvents. These products are refined to a specified flash point and have a boiling range of 90 to 220 degrees Farenheit.

Conversion Factors

The following table provides a list of conversion factors which are used in the demand model components of the Intermediate Future Forecasting System (IFFS) for the 1982 Annual Energy Outlook. These factors agree with those published in January 1983 Monthly Energy Review; with one exception, liquid petroleum gas (LPG), they agree with those published in February 1983 Short- Term Energy Outlook. In some cases the IFFS product contain two or more detailed products and in these cases the input Btu conversion factors and 1981 weights are provided.

Sector/Products	Conversion Factors	1981 Weights million barrels/year	IFFS Conversion Factors
Residential			
Electricity	3.412	NA	3.412
Natural Gas	1.026	NA	1.026
Distillate		NA	5.825
Kerosene	5.670	17	
Distillate	5.825	225	
Coal	25.060	NA	25.060
Liquid Gas	3.674	NA	3.674
Commercial			
Electricity	3.412	NA	3.412
Natural Gas	1.026	NA	1.026
Distillate	5.734	NA	5.825
Kerosene	5.670	7	--
Distillate	5.825	88	--
Coal	25.060	NA	25.060
Liquid Gas	3.674	NA	3.674
Industrial			
Electricity	3.412	NA	3.412
Natural Gas	1.026	NA	1.026
Distillate	5.825	NA	5.825
Residual	6.287	NA	6.287
Coal	25.060	NA	25.060
Liquid Gas	3.674	--	3.674
Metallurgical Coal	26.000	--	26.000
Petrochemicals	NA	--	4.589
Feedstocks			
Liquid Gas Feedstocks	3.674	--	3.674
Liquid Gas Raw Material ...	NA		5.607

Sector/Products	Conversion Factors	1981 Weights million barrels/year	IFFS Conversion Factors
Petroleum Feedstocks Naphtha 400°	5.248	83.940	--
Petroleum Feedstocks Other Oils 400°	5.825	124.421	--
Petroleum Feedstocks Still Gas	6.000	7.126	--
Industrial Other			5.951
Industrial Kerosene	5.670	19.015	--
Lubricants	6.065	55.958	
Petroleum Coke	6.024	91.860	
Unfractioned Stream	5.418	.189	
Plant Condensate	5.418	0.0	
Natural Gasoline	4.620	42.363	
Waxes	5.537	6.581	
Still Gas (Non-Feedstock use)	6.000	199.273	
Special Naphtha	5.248	--	5.248
Misc. Petro. Products	5.796	36.213	--
Asphalt	6.636	123.982	--
Road Oil	6.636	.760	--
Transportation Gasoline	5.253		5.253
Aviation Gasoline	5.048	11.147	--
Motor Gasoline	5.253	2,404.447	--

Sector/Products	Conversion Factors	1981 Weights million barrels/yea	IFFS Conversion Factors
Diesel/Distillate	5.825	--	5.825
Residual	6.287	--	6.287
Liquid Gas	3.674	--	3.674
Coal	25.060	--	25.060
Electricity	3.412	--	3.412
Jet Fuel			5.608
Naphtha	5.355	72.857	--
Kerosene	5.670	245.460	--

Note: = Not Applicable
The difference in the LPG conversion factor between IFFS and Short Term Integrated Forecasting (STIFS) reflects different product definitions. The LPG conversion factor used in STIFS excludes ethane which is a separate product in STIFS. While the LPG conversion factor used in IFFS is an average factor for all LPG's including ethane.

Note:
The conversion factors in this table represent demand model component conversion factors and with the exception of certain fuels in the industrial sectors these factors are equivalent to IFFS fuel categories. The industrial categories which must be weighted to form the IFFS categories are given in the following table.

Source: U.S. Department of Energy, Energy Information Administration, Petroleum Supply Annual 1981, DOE/EIA-0340 (81)/1. (Washington, D.C., 1982) page 36, Table 2; page 47.

Senator **Melcher**. Well, how did you ever reach a million barrels per day if you don't have separate figures, for separate components?

Mr. **Bradley**. Because the idea—as I stated before, probably better than half the demand is due to the industrial sector.

Senator **Melcher**. Probably about a million barrels? Over 500,000?

Mr. **Bradley**. Right, sir.

Senator **Melcher**. That barrels per day would be industrial and the rest would be—and those are various figures?

Mr. **Bradley**. Right, sir.

Senator **Melcher**. You mentioned that the crude prices have dropped from an average of something in February 1981, to an average of something else in October 1982.

Haven't the world crude prices dropped dramatically since October?

Mr. **Bradley**. Yes. That's right, sir.

Senator **Melcher**. How much over the weekend? What was the lowest announced price of one of the producing countries over the weekend?

Mr. **Bradley**. Over the weekend I guess Nigeria announced a price reduction in bonny light of $5.50.

Senator **Melcher**. What would that be then?

Mr. **Bradley**. That would mean the official sales price of the light bonny oil would be $30.

Senator **Melcher**. Thirty dollars; that would compare with about what North Sea prices then set in the last few days?

Mr. **Bradley**. It would be 50 cents lower than the North Sea.

Senator **Melcher**. It would be the same comparable light oil?

Mr. **Bradley**. Right, sir.

Senator **Melcher**. All right, so it is likely that we are at around $30. Do you have any spot prices over the weekend or the last week?

Mr. **Bradley**. Last week I guess the Arab light was selling at, spot price, $29.40, and the United Kingdom 40 was selling North Sea oil at $29 and light was selling at $29.75, Nigerian light.

Senator **Melcher**. That is after the latest Nigerian reduction?

Mr. **Bradley**. No, sir. That is last week, the spot market.

Senator **Melcher**. What has the Nigerian, same light oil, been this week?

Mr. **Bradley**. On the spot market?

Senator **Melcher**. Not on the spot market; it would still be $30 official sales. OK.

Now, given this trend of sharply reduced prices, when could we expect the Department of Energy to have a projection in the range of between $20 and $25, have a projection of what the consumption would be, and, because it would have a direct impact on what the price of coal would be, have a projection of what effect it would have on coal markets and other energy sources?

Mr. **Bradley**. Well, as you know, periodically studies are completed on this and primarily by the Energy Information Administration, and I have been told that their next study would be ready in 60 days, about 60 days.

Senator **MELCHER**. What period was that? Would that be current then or would it be delayed?

Mr. **BRADLEY**. That is the short-term outlook.

Senator **MELCHER**. That would be current. The projection is going to indicate a shift in consumption toward oil and away from other energy supplies. I think it is essential that we take into consideration what effect it might have on the total energy picture.

Given that, what will be the impact on the nuclear plants for generating electricity that have been under construction, either those that are still under construction or those that are under wraps? Wouldn't it place them in a very bad position, even worse than they are now?

Mr. **BRADLEY**. Well, with the $2 to $6 price decline, I don't think it will have any effect at all. I think that even with the larger decrease, you know, if that should come about, it probably won't halt construction that is underway.

Senator **MELCHER**. Won't the drop in oil prices have an effect on coal?

Mr. **BRADLEY**. Very limited effect.

Senator **MELCHER**. Very limited?

Mr. **BRADLEY**. Right, sir.

Senator **MELCHER**. Forty percent of the industrial uses that you shift from oil for, whatever they are using now, whether it is coal or natural gas, so it would be from coal back to oil, wouldn't that have a dramatic effect on the coal market?

Mr. **BRADLEY**. Well, no, but see, if you are talking about, for example, the nuclear plants, I think right now in the United States we have something like 60 nuclear plants under construction. We anticipate that over the next 6 to 8 years we will increase by 80 percent.

Senator **MELCHER**. Over the next what?

Mr. **BRADLEY**. Our capacity will increase by something on the order of 80 percent.

Senator **MELCHER**. Eighty percent?

Mr. **BRADLEY**. Eighty percent, but most of this is for future growth, growth of the economy and indeed over the last several years most of our growth, not only the United States but in the Western World.

Senator **MELCHER**. I think we are talking about a different subject, Mr. Bradley. We are trying to consider whether that the drop in oil prices means a drop in coal prices, and you are saying no.

Mr. **BRADLEY**. I wasn't trying to stray from your question. I will answer that, but I was answering, trying to answer the previous question. I guess I just didn't understand it because I thought that the question was, will the decline in oil prices affect nuclear construction, adversely affect nuclear construction, and my response was no, it will not, and the reason why it will not is because most nuclear plant construction is geared toward future growth, and it has been geared toward future growth for a number of years as opposed to displacing oil.

Senator **MELCHER**. Well then, I guess I didn't make my question clear. If the lower oil prices place a pressure on the coal market, will that not shift the emphasis again away from nuclear plant construction for electrical generation to coal because coal would be cheaper than it is now?

Mr. **Bradley**. Well, I don't see coal necessarily being any cheaper than that. It is already significantly, it is a lot less than oil, so it is going to be quite a while before the declining price of oil would force down further coal prices, so going back to the point again, we don't see any significant effect.

Senator **Melcher**. Well, it is apparent to me that it must have some relationship, Mr. Bradley, and lower oil prices causes the lower prices for other sources of energy.

Mr. **Bradley**. Yes, sir. I think at the margin, but it also can be viewed in a different way, which is why we have been considering the effort to expand the use of coal given the fact it is a low-cost energy source.

Senator **Melcher**. What way are you doing that?

Mr. **Bradley**. The President in his recent statement called for the dredging of ports.

Senator **Melcher**. Doing what?

Mr. **Bradley**. The dredging of ports.

Senator **Melcher**. For what purpose?

Mr. **Bradley**. Coal exports.

Senator **Melcher**. For shipping?

Mr. **Bradley**. Right, sir.

Senator **Melcher**. Then you are not talking about a step toward greater efficiency for domestic purposes?

Mr. **Bradley**. We are talking both because if one could get that going, then obviously that is going to drive the effort to develop the infrastructure that is needed for, infrastructure within the United States that is needed to move the coal around.

Senator **Melcher**. But that same desire doesn't relate to research and development of more effective, more efficient uses of coal?

Mr. **Bradley**. Yes, sir. That is why we have increased on the one hand the Government's budget over last year's request by something on the order of, I guess it is 27 percent, and it is also why——

Senator **Melcher**. Twenty-seven percent of what?

Mr. **Bradley**. Over last year's request.

Senator **Melcher**. Over what, though? What was that amount?

Mr. **Bradley**. The amount I think is something on the order of $109 to $138 million.

Senator **Ford**. We put in $318 million.

Senator **Melcher**. You know, somehow we live in separate spheres. There is a congressional sphere of ideas on research and development, and we have a little over $300 million appropriated which I hope we are using wisely and prudently and you are talking about 27 percent increase, going up to what, $138 million?

Mr. **Bradley**. Yes, sir.

Senator **Melcher**. Which is less than half of what was appropriated last year. Well, that seems to be somehow a play on figures to indicate there is an increase somehow in the President's budget when actually the budget request is less than half of what was appropriated last year for research and development for coal, and still very low, so I would hope that—we had some problems projecting what happens for energy demand and prices thereof when oil prices rose rapidly, and now with the scientists indicating that there is going to be a decline in world prices, I think it would be wise for the Department of Energy to have projected figures and some sort of scenario as world oil prices drop.

As Senator Johnston was leading up to, through the developing of his line of questioning, I think it has a dramatic effect on what is done in domestic oil and gas exploration, and I would look for a decline in that and I think it would be wise for the Department of Energy to project what that might mean to the domestic production in the next several years, say the next 5 to 6 years, from this year, if that occurs.

Mr. **Bradley**. We will be happy to supply it for the record.

[Subsequent to the hearing the Department of Energy supplied the following:]

The Department of Energy is currently in the process of finalizing a study of future U.S. energy demand and supply. As previously referenced, this study is expected to be completed in April of this year, at which time we will forward it to the committee.

Senator **Melcher**. Thank you very much.

The **Chairman**. Mr. Bradley, during the committee's geopolitics of oil hearings 2 years ago, one witness commented that he thought there was virtually no chance that we could get through this decade without another major oil supply interruption.

Would you agree or disagree with that assessment?

Mr. **Bradley**. Chances are—I would answer different if I can, Mr. **Chairman**. We obviously remain vulnerable.

The **Chairman**. I am not talking about our position right now. I am talking about what is going to happen out there among the producers of the world.

Mr. **Bradley**. I would say I don't know.

The **Chairman**. Obviously you don't know. What are the odds? You are not Jimmy the Greek, but I suspect you have made some kind of odds on whether or not we are going to have perfect economic and political stability in all the areas of the world over the next 10 years.

Mr. **Bradley**. Mr. Chairman, rather than doing that, I think that if one begins with the assumption, or not only assumption but the fact, that we remain especially, we along with our allies and friends, vulnerable, then one plans on that basis, and so therefore, in a way you are saying, what you are saying——

The **Chairman**. You are making plans on the basis as though there will be an interruption?

Mr. **Bradley**. That's right.

The **Chairman**. Has there been any 10-year period, any kind of rolling 10-year period in the last 30 years in which we haven't had a supply interruption?

Mr. **Bradley**. No, sir.

The **Chairman**. So we have always experienced it in the past?

Mr. **Bradley**. Yes, sir.

The **Chairman**. And the expectation is that we probably will in the future, at least we make our plans on that basis?

Mr. **Bradley**. Yes, sir. I think we should plan on that basis.

The **Chairman**. You are talking about the declines in production, in consumption, and indicate that we have got about a 10-million-barrel per day oversupply or capability at the present time in the free world.

Among that decline, you point in your statement to the fact that most of the decline in the last year has been in residual and distillate fuels. As a matter of fact, the largest decline was in residual, wasn't it?

Mr. **Bradley**. Yes, sir.

The **Chairman**. And resid is the industrial fuel, is it not?

Mr. **Bradley**. Yes, sir.

The **Chairman**. That decline in residual consumption does not reflect fuel switching or conservation over the last year as much as it does decline in economic activity, isn't that correct?

Mr. **Bradley**. Right, sir.

The **Chairman**. And if that is the case, if most of that decline came in resid and most of it because of economic conditions, then what happens if the economic conditions better dramatically?

Mr. **Bradley**. I think most of the resid has been backed out of the electrical sector, and it would probably come back but not as great as it otherwise would have, probably because of the anticipated increase in nuclear and coal-fired capability.

The **Chairman**. How fast does nuclear come on?

Mr. **Bradley**. Oh, it takes, I think the average is about 12 years I think.

The **Chairman**. But we have plants in progress?

Mr. **Bradley**. We have about 60 plants.

The **Chairman**. So it would be 12 years before any additions are made?

Mr. **Bradley**. No, sir. During the next 10-year period you would be adding on probably every year or so some capability.

The **Chairman**. And you believe that nuclear will be a large part. What will be the total shift from oil or coal to nuclear over the next 10-year period?

Mr. **Bradley**. As I stated before, Mr. Chairman, it is our feeling that nuclear will provide the growth pattern for the future.

The **Chairman**. Within the next 10-year period?

Mr. **Bradley**. Primarily the growth pattern.

The **Chairman**. You are talking about the growth from where we are today or from where we were a couple of years ago?

Mr. **Bradley**. From where we are today in terms of future plants.

The **Chairman**. So all of the economic recovery will be fueled by nuclear?

Mr. **Bradley**. No, sir. Additional—oh, I see what you are saying. Yes. Additional growth based on where we are today so that, therefore, if one argues that I guess a large measure of that would be fueled by nuclear, although I don't see that work.

The **Chairman**. A lot of people are making an assumption as recovery comes, jobs that were lost during the recession will not be replaced. Some people are assuming that there will be such a shift in our economy that we will go to a lower energy consumptive economy and, therefore, we don't need as much energy coming out of this as we did going in.

What you are implying is that what DOE is saying that the nuclear that was planned for future growth when we had a robust economy will be enough to provide all the increase that is necessary just to get out of the recession that we are in as well as the growth in the economy.

Mr. BRADLEY. No, I don't think, that will not be sufficient. What I am saying is that the nuclear and coal will primarily be for growth purposes, but that does not mean that oil will not also be used for growth and to get back where we were before. So what I am saying is that nuclear and coal I don't see as displacing oil.

The CHAIRMAN. Nuclear and coal won't displace oil?

Mr. BRADLEY. Not in any significant amount.

The CHAIRMAN. If the economy recovers, then you would expect that we go back to the same level of oil consumption we had before?

Mr. BRADLEY. Not totally, no.

The CHAIRMAN. Why not?

Mr. BRADLEY. Well, because I think that given the, we have the appropriate policy structure, one that would allow free operating of the marketplace, so that, for example, it results in an increase in gas production and it results in stepped-up development of nuclear, then we can anticipate that we will not have to get back where we were before. Some of these things are being constrained by the policy framework that we are currently operating under.

The CHAIRMAN. Let me test that just a moment. All of the nuclear that we will have in the next 10 years is already underway, isn't that a fact? The working of the free market isn't going to change that?

Mr. BRADLEY. Well, I would say it is debatable.

The CHAIRMAN. Let's debate it for a minute. How is the free market going to bring more nuclear on in the last 10 years that is now underway?

Mr. BRADLEY. We have had, as you know, some concerns of perception within the public that nuclear poses some degree of problems.

The CHAIRMAN. How long does it take to build a nuclear plant?

Mr. BRADLEY. Well, if you can accelerate the licensing process, you probably could build it in 6 years, but historically it has taken——

The CHAIRMAN. You said "if." We haven't yet done that, have we?

Mr. BRADLEY. Right.

The CHAIRMAN. I share with you the hope that we will, but are you making your statement on the basis that we will and that we can then, we will build those plants faster?

Mr. BRADLEY. Exactly; these are the constraints that I am speaking of—if we can remove those restraints.

The CHAIRMAN. My own expectation is that the great bulk of the nuclear that will be on line 10 years from now is that which is underway today; and if it is not underway today, it won't be on the line 10 years from now. I may not like that, but I think that is exactly what we can expect.

Mr. BRADLEY. I agree with you, sir.

The CHAIRMAN. Future nuclear is only what we have underway now, and what we have underway now is that which was planned before we went into the recession—there hasn't been anybody planning one since we went into the recession. Then if nuclear can't contribute to the backout of oil in the future over the next 10-year period, it must be coal switching?

We don't have much evidence that there has been much switching from resid to coal, in the last 10 years, do we?

Mr. BRADLEY. Oh, yes, sir, we do.

The CHAIRMAN. All right. Show me the figures.

Mr. BRADLEY. Can I ask Al who is here from EIA who deals in these numbers?

Mr. LINDEN. Yes, Mr. Chairman.

The CHAIRMAN. Would you state your name for the record?

Mr. LINDEN. I am Al Linden, Deputy Administrator, Energy Information Administration.

In our monthly energy review we have summarized the data for the use of the major fuels by the electric utility sector. If you will look there. You will see that in 1973 we produced 847 billion kilowatt hours of electricity from coal; in 1981, we generated about 1.2 billion kilowatt hours.

The CHAIRMAN. That doesn't necessarily mean that that is a net backout of resid. That could be new plants.

Senator FORD. And it is.

Mr. LINDEN. A lot of that is, but we have also had a decrease in the amount of residual fuel oil that is being used to power our electric utilities, if you just look. We have been looking at that. We have been watching for the last 3 months for an indication that what we have heard in the trade press and also in some of our public comments that people are now switching back to residual fuel oil from natural gas.

The CHAIRMAN. I could just pick some figures out of your table as an example. Remember that we started in the recession some time ago. It didn't just suddenly land on us. Look at the 1979 figures that are above the 1975 figures. As an example, just in burning petroleum now, that is not all resid. Some of that is distillate, particularly in California where they have Clean Air Act requirements, and pollution control requirements that require that control in the utility boiler, but what I am looking for is specific information with respect to how much, how many plants switched from burning resid to burning coal.

Mr. LINDEN. We have that information and we will be glad to supply a list of plants that converted under FUA for the record shortly, but if you also look at page 25 you will see that there has been a significant decrease in the use of petroleum for the input into electric utilities.

[Subsequent to the hearing the Department of Energy supplied the following:]

PERMANENT CONVERSIONS ACCORDING TO UTILITIES

A. CONVERTED UNDER ENERGY SUPPLY AND ENVIRONMENTAL COORDINATION ACT OF 1974 (ESECA) ORDERS

Utility	Plant	Unit	Capacity (MW)	Year Converted	Contact/Phone Number
Iowa Public Service	Maynard	7	54.0	1973	Harward/712-277-7722
Ames Electric Municipal System	Ames	7	33.0	1973	Merlin Hore/515-232-6210
Wisconsin Public Service	Weston	2	75.0	1977	E. Mathews/414-433-1300
Kansas City Power & Light	Tecumseh	5	81.6	1976	Neil Roadman/816-556-2700
		6	149.5	1976	
	Lawrence	3	49.0	1976	
		4	114.0	1976	
		5	403.0	1976	
Nebraska Public Power	Shelden	1	105.0	1974	Rhodes/402-563-5301
		2	122.0	1974	
Alabama Electric Corp.	McWilliams	3	25.0	1974	A.G. Palmore/205-222-2571
Savannah Electric & Pwr. Co.	Port Wentworth	1	58.8	1979	Billy Aken/912-964-7476
		2	64.0	1979	
		3	115.0	1979	
New England Power	Brayton Point	1	241.0	1981	D. Lawrence/617-366-9011
		2	241.0	1981	Ext. 2880
		3	642.6	1982	
Vepco	Chesterfield	3	112.5	1984	Wadell/804-771-1138
		4	187.5	1980	
		5	359.0	1975	
		6	694.0	1975	
	Portsmouth	3	185.0	1982	
		4	239.0	1979	
Northeast Utilities (Holyoke Power & Light)	Mt. Tom	1	136.0	1982	Ms. Stavola/203-721-2332
TOTAL MW:			4,486.5		

PERMANENT CONVERSIONS ACCORDING TO UTILITIES

B. ESECA ORDER RESCINDED BECAUSE CONVERTED

Utility	Plant	Unit	Capacity (MW)	Year Converted	Contact/Phone Number
Independence City Power & Lt.	Blue Valley	1	25.0	1979	R. Badger/816-796-4400
		2	25.0	1979	
		3	65.0	1979	
Pepco	Morgantown	1	626.0	1978	Ocalahan/301-872-3415
		2	626.0	1978	
Central Tel. & Utilities	N.W. Clark	1	22.0	1978	G. Perry/303-545-0360
		2	22.0	1978	
United Power Association	Elk River	1	11.5	1978	Shunts/612-441-3121 Ext. 490
		2	11.5	1978	
		3	22.0	1978	
Dept. of Public Utilities	Martin Drake	5	50.0	1974	B. Coy/303-636-5590
		6	75.0	1974	
		7	132.0	1974	
Vineland Electric	Down	10	27.2	1979	J. Dorfee/609-639-3000 Ext. 405
Florida Power	Crystal River	1	440.5	1979	
		2	523.8	1976	
Fremont Dept. of Utilities		7	22.0	1976	J. McCafferty/402-721-2490
Atlantic City Electric	B.L. England	1	136.0	1974	McCullough/609-645-4398
		2	163.0	1974	
Springfield Utilities	James River	3	44.0	*	L. Ramsey/417-831-8705
		4	60.0	*	
TOTAL MW:			3,129.5		

* Switching back and forth by the year and during the year.

PERMANENT CONVERSIONS ACCORDING TO UTILITIES

C. CONVERTED UNDER POWER PLANT AND INDUSTRIAL FUEL USE ACT OF 1978 (FUA), AS AMENDED BY OMNIBUS BUDGET RECONCILIATION ACT (OBRA)

Utility	Plant	Unit	Capacity (MW)	Year Converted	Contact/Phone Number
New England Power Co.	Salem Harbor	1	82.0	1982	D. Lawrence/617-366-9011
		2	82.0	1982	Ext. 2880
		3	170.0	1982	
TOTAL MW:			334.0		

D. FUA ORDERS NOT FINAL BUT CONVERTED

Utility	Plant	Unit	Capacity (MW)	Year Converted	Contact/Phone Number
Atlantic City	Deepwater	8	74.0	1982	McCullough/609-645-4398
Vepco	Possum Point	4	239.0	1980	Wadell/804-771-1138
TOTAL MW:			313.0		

E. OTHER CONVERSIONS

Utility	Plant	Unit	Capacity (MW)	Year Converted	Contact/Phone Number
Atlantic City Electric Co.	Deepwater	7	23.0	1982	McCullough/609-645-4398
		9	23.0	1982	
TOTAL MW:			46.0		

TOTAL CAPACITY FOR ALL CONVERSIONS (A,B,C,D,E): 8,309.0 MW

The **Chairman**. Of course there is. Detroit isn't burning much electricity, and those were mostly coal-fired plants, weren't they?

Mr. **Linden**. Yes.

The **Chairman**. In the Great Plains, and right now they are not using much.

Mr. **Linden**. But the point I am trying to make, Mr. Chairman, is that the use of petroleum in the electric utility sector has decreased faster than has the use of electricity.

The **Chairman**. Isn't it true that in many systems coal is the base power for electric generation?

Mr. **Linden**. Yes.

The **Chairman**. And oil is the peaking power?

Mr. **Linden**. Oil or natural gas.

The **Chairman**. It would be the first that comes out when there is a decline in consumption of electricity, and it would come out much more dramatically than would baseload.

Mr. **Linden**. That's right.

[Subsequent to the hearing the Department of Energy supplied the following:]

In fact, the backout of oil and gas should be more dramatic in baseload than is the peaking mode. This is because, in baseload, oil and gas are the highest cost production sources and, thus, would be the first logical choice to cut back. On the other hand, if electricity consumption declines the peakload consumption is reduced about proportionally. For technical reasons, oil- and gas-fuel plants are good choices for supplying peaking demand. Thus, we might expect the use of oil and gas for peaking to decline proportionally to the decline in overall electricity demand.

The **Chairman**. Statistics then become almost totally meaningless in terms of what is the movement over a period of time with respect to fuel switching.

Mr. **Linden**. Yes, but if you look at the productive capacity of, or the use of, nuclear powerplants, you will see that nuclear normally carries the baseload in electric utilities. You will see in these data that the use of nuclear, in other words, the percent operating capacity is also down so that leaves room to pick up some additional generation from nuclear that you might not otherwise expect when the economy picks back up and you start using more. electricity. This potential increase in nuclear generation could help reduce oil and gas consumption even more.

The **Chairman**. And we say make some changes in the licensing regime, and that allows them to produce a little more out of existing plants. I understand that, but what I am really looking at is the assumption that there has been extensive fuel switching away from coal toward others. That would include the expectation that as consumption of electricity rises, that it will not be oil that goes back on line. My assumption is quite to the contrary to that, not maybe a hundred percent replacement, but it will be a lot higher than these statistics indicate.

Now if I might just for a moment, because we have some very good witnesses yet to be heard from and I want to get to them as well, part of the decline in consumption is reduction in inventories, is it not?

Mr. **Bradley**. Right.

The **Chairman**. And that instrument that I recall correctly is about 4 million barrels a day.

Mr. **Bradley**. On average it fell about 1.3 in 1982.

The **Chairman**. One point three; the inventories are drawn down about 1.3 million barrels a day?

Mr. **Bradley**. Right, sir.

The **Chairman**. That is interesting because the answer we got last week was four. What changed over the weekend?

Mr. **Bradley**. That is right now. We think the drawdown, we think that the drawdown, we think that the current drawdown is something in that range, but the average for last year was something——

The **Chairman**. Current drawdown is about 4 million barrels a day if we look at current demand? If we look at the apparent demand which is measured by purchases, that doesn't measure current consumption unless we add to it the amount of inventory drawdown, is that correct?

Mr. **Brodman**. That would be correct insofar as our figures do not capture the drawdown of inventories at the secondary and tertiary level.

However, a drawdown of inventories at the primary level is captured in our consumption.

The **Chairman**. Yes. I understand that, but if the drawdown totally is around 4 million barrels a day, the apparent demand is less than real demand?

Mr. **Brodman**. Most likely.

The **Chairman**. If people weren't thinking oil prices were dropping; if they didn't pay high interest rates for inventories; if they anticipated that future economic activity was going to become more robust, then they would start building inventories rather than drawing down on inventories, and at that time apparent demand becomes greater than real consumption.

Mr. **Bradley**. Right, sir.

The **Chairman**. So you get a very quick turnaround in those figures based upon those variables that affect people's decision as to whether to build inventory or draw down on inventory?

Mr. **Brodman**. It is possible.

The **Chairman**. And if during that period of time you run across any kind of supply constraint at all, then the psychology begins to say bid up the price, isn't that correct? People really want to build their inventories. They start bidding more for supply.

Mr. **Bradley**. But you have got spare capacity.

The **Chairman**. I understand that, but you have spare capacity of about 10 million barrels a day, but if 4 of that is drawn down, then you have got 6, not 10, and if you have recession recovery—supposing instead of drawing down inventories of 4 million barrels a day they start adding to inventories at 4 million barrels a day. There goes 8 of your 10 just by one movement in the marketplace.

Mr. **Bradley**. It is unlikely.

The **Chairman**. It is unlikely?

Mr. **Bradley**. To have that wide a swing I think.

The **Chairman**. We have got it on one side. Why did you say it is less likely it will happen on the other?

Mr. **Bradley**. Well, I think it is because of the psychology of the marketplace now.

The **Chairman**. If they are confident that supply will be greater than demand they are less likely to start adding inventories. If that is the case, inventories will remain very lean. If that is the case, we have less to depend upon in case of any kind of an emergency which, by your testimony, you admit may occur at some time and probably will within the next 10 years; and the next 10 years starts this minute. It could happen in the next hour.

Mr. **Bradley**. Mr. Chairman, the level of inventories is now I think about worldwide, free world, about 4.8 billion, which is the same level at which they stood in 1978, and the forward consumption is about, it is about 105 days of forward consumption, so we are in pretty good shape.

The **Chairman**. Could you give me the breakdown between crude inventory and refined inventory?

Mr. **Bradley**. Crude inventory and refined inventory?

The **Chairman**. Dr. O'Brien, do you have that?

Dr. **O'Brien**. No, I don't, but I think that one—and we sometimes assume that everyone knows these numbers are very, very flaky in the sense that no one really knows how much there is in the secondary and tertiary area of stocks as we indicated last year and even the secondary and primary stocks are not that measurable—I think what is more important is to concentrate on trends, and it is highly unlikely that, as Mr. Bradley has indicated, it is highly unlikely that we would have that kind of drawdown over any sustained period of time. It might occur for a short period of time but not for a long period of time, and we still do have a cushion of inventory or excess capacity which is 10 million barrels a day.

You also have refinery flexibility which was not present in the 1970's which gives you a lot of opportunity to select different kinds of crude to satisfy that short-term demand.

The **Chairman**. Did I understand you, Mr. Bradley, to say that the inventories are about now where they were in 1978?

Mr. **Bradley**. Yes, sir.

The **Chairman**. I invite your attention to the graph on page 7 of the Energy Information Administration's weekly petroleum report dated February 18.

Mr. **Bradley**. I was talking free world, sir.

The **Chairman**. The free world stocks are much higher than normal then, is that correct, non-U.S. free world stocks?

Mr. **Bradley**. Yes, sir.

The **Chairman**. Are you talking about now, when you are talking of the inventory, you are talking about strategic reserves in the hands of governments?

Mr. **Bradley**. It includes that, yes, sir.

The **Chairman**. It includes that?

Mr. **Bradley**. Yes, sir.

The **Chairman**. Page 7 would indicate that U.S. stocks are far below the average range of stocks.

Mr. **Bradley**. Consumption is lower, too, sir.

The **Chairman**. I didn't ask about consumption. I was talking about stocks.

Mr. **Bradley**. Well, but what we are concerned about is consumption as well.

The **Chairman**. I understand that, but all I am trying to get to now is that you have said that our stocks are as great as they were in 1978, and this graph indicates we are not where we were in 1978. We are below the normal operating range.

Mr. **Bradley**. I was referring to free world stocks, and I think even if you—I was referring to free world stocks, sir.

The **Chairman**. And that implies then that United States is drawing down and the rest of the free world is building inventories, is that correct?

Mr. **Bradley**. Not necessarily, no, sir.

The **Chairman**. Well, if we are down and the free world is not, then the rest of the free world must be up. I am not a mathematical genius. Maybe I am missing something here.

Mr. **Bradley**. Well, the idea being that one would have to look at, as I said, the total equation and my understanding of U.S. stocks, we are at 1.4 billion barrels at the present time, which includes the 300 million barrels in the strategic petroleum reserve which is about where we were, in terms of both private stocks and the SPR combined in 1978. That is about where we were in 1978.

The **Chairman**. I will not belabor the point. I go back to the weekly petroleum status report that indicates U.S. stocks are below the average, well below the minimum that have been heretofore observed. There was comment made earlier about the rate at which we are adding to the strategic petroleum reserve, and I want to commend Secretary Hodel for having increased the purchases in recent weeks.

As I understand the figures for the last 4 weeks it would indicate an average over the last 4 weeks of 233,000 barrels a day. Is that correct?

Mr. **Bradley**. Something on that order.

The **Chairman**. And I appreciate that action, but that has to be contrasted with the average for 1982 through November of only 167,000 barrels a day. It seems to me that while the new purchase orders are welcome, they are going to be pressed to come up with 220,000 barrels a day average that the law mandates.

I don't think any Secretary really wants to make the President a violator of the law, and the Congress has indicated that we should buy at an average rate of 220,000 barrels a day. I assume Secretary Hodel's most recent action will be typical of the Department. Am I correct?

Mr. **Bradley**. Certainly. I had assumed that Secretary Hodel had responded to that question. I am not aware of exactly of his plans with respect to 1984, but I am certain that we would take into account the desires of Congress.

Mr. Chairman, may I just comment? I guess my reflection in terms of the figures for the——

Senator **Ford**. Would you please use the microphone?

Mr. **Bradley**. I was assuming that our inventories in 1978 were one, four, which is at the same level now. I have been told that actually they are a little higher that one, four, and so if you include the strategic petroleum reserve, sir, I just want to put that on the record.

The **Chairman**. If I understand the figures correctly, so far as U.S. oil stocks are concerned, if you include SPRO, we are up 13 percent since 1978. If you exclude the SPR, our stocks are down 5 percent?

Mr. **Bradley**. That is correct, sir.

The **Chairman**. The reason I am undertaking this line of questioning is that the Congress is, and continues to be, very concerned about the Strategic Petroleum Reserve. While we are now filling at the mandated rate, at least in the last 4 weeks, we have not been during the year to date. That concerns a great many of us from the standpoint not only of test of wills between ourselves and the administration, but a judgment of the danger to our country or the necessity of having a strategic reserve that is adequate to meet that plan for contingency of some kind of supply interruption.

We don't know where it will happen or when it will happen, but we plan as though it will happen, and I think it is fair for us to note for the record, too, that the strategic petroleum reserve is virtually the only thing we have in our arsenal to respond to an emergency.

I would like to call attention to the fact that the GAO was asked by myself and some others to undertake a study about our ability to respond to a crisis, to an emergency, and their report that was just released late last week indicates that we are not prepared. It is my conviction, along with most of the rest of the members of this committee on both sides of the aisle, that we are not prepared; that the GAO is indeed correct in that report. I think their conclusion is just irrefutable, and that is that the United States simply is not prepared for a significant oil interruption, despite the progress that has been made during the last year under the Energy Emergency Preparedness Act of 1982.

I did meet with Mr. Clark, the President's National Security Adviser, and Secretary Hodel last week, and I have called on the administration at the very highest levels to act upon the basis of the GAO report to insure that adequate energy emergency preparedness will be established as soon as possible.

I hope to continue to work very closely with the administration in that effort, but I suspect just on the basis of the information that you have given us this morning, we have done nothing in the hearing so far this morning to indicate any degree of inaccuracy in the GAO's report. We don't know where secondary and tertiary stocks are, where they are held or what quantity.

We have a pretty good idea of primary stocks, and we will know where secondary stocks are in the hands of major users such as utilities.

We also don't know when an emergency will occur, but it was only 10 days ago that there was one of the largest military battles of the decade between Iran and Iraq. Iran didn't win that battle. They were at a standoff. In spite of the fact that is not on the front pages of our newspapers, that did occur, and that is fact. That war hasn't ended, but there were a lot of us, and I suspect a lot of you down in the administration, who were holding your breath waiting to see what was going to happen, and if that single battle had turned out differently and Iran had been successful in pushing into Iraq, it could very well have had very massive influence upon the availability of oil.

As a matter of fact, Iran's failure may have adverse effects throughout the Gulf region as the politics of that region are affected by that continuing conflict between Iran and Iraq. We don't know when that will happen, but I remember when it last happened and caused a world oil marginal shortage. We have got more of a cushion now than we had then certainly, but that cushion in apparent demand will evaporate overnight in the light of apparent shortage. Remember that some speculator with a million barrels of oil in a supertanker on the high seas who can divert that tanker or delay its delivery date long enough to get just $1 a barrel difference in the price, he has made a million bucks. The leverages on the market are so tremendous that the speculators run rampant during a period of uncertainty and we are acting as though that will never happen again, and all I can say is it has happened repeatedly during the last several years, and in any 10-year period it happens at least once and usually twice.

I think it would be very foolish for our country to assume that because we have an embellishment of riches in supply today that that is going to continue over the next 10 years, and you indicate that our planning should include in it the contingency of a supply interruption.

What I perceive is the assumption that a 10-million-barrel cushion is more than enough to take care of any such supply interruption. I emphatically disagree with that.

Mr. **Bradley**. May I comment, Mr. Chairman?

The **Chairman**. Certainly, Mr. Bradley.

Mr. **Bradley**. Mr. Chairman, over the years we have been well aware of your concern about a number of these things, and as Secretary Hodel has said, and certainly I am sure in your discussion with he and Judge Clark, revealed that a number of these things have been taken into account. It is not accurate to assume that the administration is giving absolutely no thought to these kinds of things. We have been actively participating with the—in fact, International Affairs has been actively participating with the NSC and State Department in thinking through how we might proceed, but more importantly I think is that we recognize that there is an existing mechanism through which one can attempt to deal with these situations, and that being the International Energy Agency, and of course, the administration has voiced its support for that agency and in various meetings there we have also taken into account how we might go about responding to certain situations.

On the other hand, there is also a strong belief in the administration which I share personally that being a country of free traders, we should attempt to allow the free market to work and we should do everything possible to do that.

At the same time, that does not preclude one having possible tactics that one would use under a given situation, but at the same time we certainly don't want to signal the market indicating that we will move in and do something, but just to repeat, in terms of Government and acting as leaders in Government to insure that security concerns are taken into account, this administration has been actively involved in that.

The **Chairman**. Well, I would again invite your attention to the conclusions of the GAO. You may have been thinking about it, but the results of your thoughts don't get shown.

Mr. **Bradley**. Right, sir, and I might add that no one from GAO, for example, spoke with me, and I will be happy to——

The **Chairman**. I understand that they did, as a matter of fact, supply the Department of Energy with an interim draft of their report for comments, and DOE did comment upon their draft report before it was published, so the DOE has had the opportunity for input into that study, even though you might not agree with its conclusions.

Senator **Ford**. Mr. Chairman, I just want to make one point if I may, and I apologize for delaying the other witnesses, but Mr. Bradley, when I questioned you early on you indicated that this administration was interested in all sources of energy for the basic energy economy.

Mr. **Bradley**. Right.

Senator **Ford**. Something is out of kilter, and I point back to your statement that you asked for additional funds in fossil R&D over the request of the year before but which was approximately 200 million less than the Congress actually appropriated. I am going to give you some figures here. I want to ask you if this indicates that you are trying to spread the energy field as broadly as you indicated earlier.

In the 1981 budget which was not basically this administration, but you find nuclear fission and waste disposal at 28 percent of the DOE energy technology budget. Now I am not going for the rest of it; fusion at 11 percent; solar and renewable at 20 percent; fossil energy at 22 percent; and conservation at 19 percent, with the budget of $4 billion.

The budget, it begins to shift a little bit in 1982. The budget was 2.8. In 1983 the budget was 2.4, and now your request for 1984 is $1.9 billion. Of that $1.9 billion, however, 84 percent is nuclear, 4 percent conservation, 7 percent fossil, 5 percent solar and renewables, and all through this administration, the 1981 budget of the $4 billion, $1.6 billion went to nuclear. Of the $2.8 billion—these are round figures—$1.5 billion went to nuclear in 1983 whereas it was reduced to 2.4, almost half of the 1981. You kept 1.488 in nuclear, and when you reduced the budget to 1.9 in your request, your request of $1.6 billion of a total $1.9 billion, almost all of that is nuclear.

Now, Mr. Bradley, can you testify for the record that you all are doing everything you can as it relates to all sources of energy?

Mr. **Bradley**. Yes. I would say yes, because again the amount of money that is actually placed in the budget is not indicative of necessarily how much activity is going on in the society with respect to these various technologies, nuclear per se, and I personally am not an advocate of any particular technology or energy source, but I am an advocate of utilizing any source we can so that we can create jobs for the American people, and I think that we all are aware that nuclear is a viable source, is an indigenous source, and something that can supply the Western World, and there are answers that we need to move toward getting, and one of those answers is waste as well as building more advanced reactors for the future, and the nuclear industry, as you well know, is an industry that was originally established by Government so that one——

Senator **Ford**. So was the synthetic rubber industry and we are no longer in it.

Mr. **Bradley**. I understand, but since we have got the answer, since we have got the answer to that, and it is existing in our econony, I think we need nuclear to do the same thing, and it is certainly something that we can rely on immediately to provide jobs for the American people, and so that, therefore, we need to provide the funding to deal with our waste problem, for example, which Congress has mandated itself, so you have a larger funding whereas on the other hand something like fossil energy, there are a number of projects that are not only funded by Government but are also funded by the private sector, for example, the coal to methanol project in Germany which is a useful project.

There are some projects that we would anticipate, I think there are seven projects being considered and one is currently under construction by the Synthetic Fuels Corporation immediately so that these——

Senator **Ford**. How many has the Synthetic Fuels Corporation awarded to date?

Mr. **Bradley**. Well, I think that the answer to that is none.

Senator **Ford**. That's right.

Mr. **Bradley**. There is one project with Union Oil that is currently under construction, but that is not the point. The point is that obviously if they are considering these projects, then there is no need for DOE to have funding at a level that it had in the past when the Synthetic Fuels Corporation did not exist is the point.

Senator **Ford**. You are not spending any—I apologize. I am going to quit—because the point we are making here is that you have cut the budget from 1981 to your request for 1984 better than half for technologies, and you have increased the nuclear and waste disposal from 29 to 84 percent of that budget, and none of that money has decreased over a 4-year period upon your request and what has been appropriated.

The ones that have suffered are solar, is fossil, is conservation. Those things the Government ought to take some kind of leadership in, don't you think? It is just as tough, it costs just as much money to build a coal plant to turn it into liquid or to gas as it would a nuclear plant. You don't see any of those exploding or having trouble or shutting down or finding any of the coal-fired utilities.

You come down, walk up and down the Ohio River with me and see how many of those nuclear plants are operating that have been trying to get underway. I talked to all of the inspectors last week. I understand what is going on. The employees in the plants are squealing. That's the reason we are getting NRC in here to make investigations. You don't find that in a coal-burning facility.

Mr. **Bradley**. Well, Senator, you know, I guess the thing that alarms me is the fact that I have heard over time the concerns and the expression of alarm about exploding nuclear plants, and excuse me for use of the word, but which I find ludicrous because we all know that that is not the case, and I think we need to cease using those kind of terms, especially when we are talking about such things as emergency situations.

Senator **Ford**. Why should I quit using that term when you say you are increasing the appropriation request over last year? You quit saying that—it is a $200 million cut from those that were appropriated last year. You change your terms. I'll change mine.

Mr. **Bradley**. Yes, sir. I would just like to finish the comment, and the fact that we are talking about the Western World being vulnerable. We are talking about where do we go and how do we get there in the future? We are talking about jobs for the American people and for the industrialized world, and so we need to turn to things that are viable, and certainly nuclear is viable as well as solar and fossil. No one is excluding anything, but we certainly shouldn't exclude nuclear.

Senator **Melcher**. Mr. Bradley, you have used that term "jobs for Americans" in an economic recovery sense for at least four times today, but how does nuclear—just to pay the interest on the debt is going to cost 80 mills and perhaps nuclear plants that are under construction will be generating electricity at somewhere around, and sell it for 100 mills. How can that possibly lead to any jobs in a type of industry that uses a lot of electricity when that is so much higher and so much inflationary and these plants are closing down when they are paying 30 mills or less?

How could conceivably rolling in a new electrical generation of 100 mills create jobs without being freely inflationary?

Mr. **Bradley**. I would say, my response to that would be that that is micro. I think one has to look at these things in more of a macro picture.

Senator **Melcher**. If we are going to look at macro, shouldn't we look at the relationship of cost of generation of electricity on the nuclear plant as compared to building a new coal-fired plant to generate electricity? They are coming in at half of what it costs to generate electricity for using nuclear.

Mr. **Bradley**. That's right, sir, but I think first, and I think the typical case would be France——

Senator **Melcher**. Pardon me?

Mr. **Bradley**. The typical case would be France. First you have got to say do I have anything? And what I am arguing is that nuclear is an indigenous capability.

Senator **Melcher**. So is coal.

Mr. **Bradley**. Well, absolutely; I am not arguing that point, but if you say we are going to supply coal, it would be just as usable and just as good.

Senator **Melcher**. The point is that one costs 50 percent less. The new plants that are coal-fired generation of electricity are 50 percent less than the nuclear plants.

Mr. **Bradley**. Again, it is best to look at these things in a global view, and I am not looking at just the United States. I think what you are referring to is the U.S. market, and I am thinking of the Western market.

Senator **Melcher**. We are speaking about the U.S. market, creation of jobs for Americans.

Mr. **Bradley**. And the Western World.

Senator **Melcher**. Well, the point is I guess, Mr. Bradley, and perhaps you are not in a good position to say so, but the research and development for utilization of an energy source in a more efficient manner is clearly not demonstrated by the administration's budget for research and development where it is all nuclear, and it is all going that way rather than going to the other sources. Coal is one example and perhaps the best example.

Thank you very much.

The **Chairman**. Let me yield to Senator Warner.

Senator **Warner**. Thank you, Mr Chairman. Over the past 10 days the Senate has received a series of briefings, all behind closed doors, because of the sensitivity of the classified nature of the information relating to the need for additional credit of the International Monetary Fund, and part of those briefings have included the direct linkage of the world oil supply and the decline of prices to this issue.

My judgment of this issue is it is one of the most serious facing the free world in the coming year. My question to you is you were present it is my recollection on the one last Thursday, wasn't that correct?

Mr. **Bradley**. Friday, sir.

Senator **Warner**. I guess it was Friday. There have been so many, and can you share with us in any way your convictions about the linkage between the decline in world oil prices and the need for additional credit for the IMF?

Mr. **Bradley**. Sir, I really think that is a Department of Treasury issue.

Senator **Warner**. I recognize earlier my colleague from Kentucky raised this issue with respect to the domestic banking, but there is an interagency group of which your Department it is my understanding is a part studying this, and I think it is imperative that the administration gets this story out in some form into the public domain. It is essential for those in particularly the financial community that they begin to have the benefit of these analyses and to form some appreciation for the seriousness of the problem.

Do you share my belief in that?

Mr. **Bradley**. Well, I can say, sir, that certainly the administration has been studying the issue, but as I said, I think that it is something that the Department of the Treasury should comment on.

Certainly we wouldn't want, I wouldn't want to be, as someone who deals in energy, to try to talk about the banking system.

Senator **Warner**. Don't you think there is a linkage between the worldwide oil supply and pricing structure and this issue?

Mr. **Bradley**. I just wouldn't even want to comment on it.

Senator **Warner**. Thank you, Mr. Chairman.

The **Chairman**. Thank you, Senator Warner, and thank you gentlemen for your testimony this morning. We appreciate your appearance and your patience in the face of all these questions.

Our next witness is Dr. Herman T. Franssen, Chief Economist of the International Energy Agency.

Dr. Franssen, your entire statement will be made a part of the record, and you may proceed as you see fit to summarize or highlight it.

STATEMENT OF DR. HERMAN T. FRANSSEN, CHIEF ECONOMIST, INTERNATIONAL ENERGY AGENCY

Dr. FRANSSEN. Thank you, Mr. Chairman. It is a pleasure to appear again before this distinguished committee, representing the International Energy Agency of Paris.

We have seen some very dramatic changes in the world oil market ever since 1973 which has left very severe shocks to the world economy. As a result of the first and the second oil shock in the world, 1973-74 and later 1979-80, the industrial countries have suffered the lowest postwar growth, the highest rate of inflation, the biggest budget deficits, the highest balance of payments deficits, and the biggest increase in unemployment ever since the Second World War.

The direct impact of the second oil shock alone in fact of 2 years, 1980 and 1981, on the OECD economies was a loss of GNP projected at $1 trillion, or $1,500 for every man, woman, and child in the industrial countries, and that is just the impact on 1980 and 1981.

The 1974-75 oil shock led to a deep recession followed by a rather robust recovery in the second half of 1975. Energy demand was restored fairly quickly led by oil in past because the investments in oil energy hadn't been taken off yet.

In 1976, just 2 years after the oil shock, the demand for OPEC oil was getting very close to the direction again of what it was prior to the oil shock. Major producers increased production and the price was allowed to soften somewhat in real terms between 1974 and 1978.

As you recall, Mr. Chairman, there was a lot of talk about the price collapse at that point which then did not occur, and on the other hand, there were banking institutions talking about a permanent OPEC surplus which did not occur either, and as late as 6 months before the Iran revolution the consensus among the energy industry was that nothing would happen, no new oil shocks, no big price increases at least through 1985, if not 1990. This was in 1978.

Then we got the 1979-80 oil shock and the deep recession that followed. The recession in fact deepened in 1982, was worse than the previous years, at first because of very high inflation like after the first oil shock. Gradually the inflation rate was reduced but at the expense of economic growth and we ended up now with the highest unemployment that we have had since World War II—32 million unemployed in the OECD countries, so the recession has slowed down trade, has led to growth in protectionism, and the LDC debt problem that was referred to earlier this morning, all of which would not have occurred if we had had economic growth.

The recession and the price impact plus, of course, investment decisions that were made after 1973-74, reduced energy demand. In 1980-81, when we had still some positive economic growth in the industrial countries of about 1 percent, energy demand dropped by approximately 2½ percent per year, but oil demand dropped by approximately 7½ percent per year, at a much higher rate, but it is interesting that in 1982 when we had negative economic growth, minus one-half percent in the industrial countries, energy demand continued to drop at a slower rate than it had prior to 1982, about 2 percent per year in the industrial countries, and oil demand also dropped at less than it did before, at about 5 percent per year, so this may mean a possible slowdown of the decline in energy demand and substitution away from oil.

If you look at the testimony in figure 1, it shows quite clearly free world oil demand dropped quite rapidly from just about 52 million barrels in 1979 to 45½ million barrels a day in 1982. The biggest drop was in the United States, almost 4 million barrels a day over that period out of this total.

It is very difficult to separate the effects of recession, conservation, belt-tightening, fuel-switching, but each of all of these have a share in it. Coal use grew very rapidly, by about 17 percent since 1979, and nuclear even more rapidly, at about 34 percent over that period.

OPEC suffered more than it did after the first oil shock so far. While oil demand dropped by about 6½ million barrels a day between 1979 and 1982, non-OPEC supply increased by about 4½ million barrels a day, and that made, therefore, the total reduction, the total call on OPEC, much more severe at the tune of about 11 million barrels a day for one-third of its capacity, so OPEC's share has now been reduced in the oil market from about 59 percent in 1979 to about 43 percent last year.

The OPEC problem is aggravated by the fact that they are now beginning to run into some very serious difficulties in part based on budget expectations in previous years which were based on expectations that the demand for their product would be higher and that subsequently the price would at least remain what it was in the good years in 1980, 1981, and that didn't happen to the surprise of almost everybody in the industry. For example, in mid-1981 we projected that the call on OPEC in 1982 would be 6 million barrels a day higher than what actually happened, and we do not represent any different set of estimates than most other industries, so it is clear that the price of oil went up too fast too soon, and that the subsequent recession, that we got weaker demand, in a period of weakened demand, a great deal of competition in the industry. The product netback which is what the industry gets for the oil it buys continued to be negative for imported crude, and particularly the ARAMCO part suffered the great disadvantage of having to pay a higher price for the crude than most others.

OPEC had hoped that inflation would rapidly reduce oil prices over the next few years and that was apparent in many statements that came out in recent years, and then it happened, and to add insult to injury, we got one of the mildest winters on record in Western Europe, Japan, and North America in the fourth quarter of last year, continuing early this year. Fourth quarter oil demand fell substantially in the industrial countries.

OPEC was aware of the problem. In fact, they issued a very famous study in late December where some very famous former Secretary Generals of OPEC were talking about the possibility of an oil price collapse if this continued. It didn't stop and OPEC didn't come up with firm policies. They met in December and no real firm agreement was reached. They met again in January, as you recall, and Shiek Yamani said after the meeting that no agreement was reached in part again because of the mild winter, caused by continuing decline in consumption, possibly exacerbated by some stock draw at the secondary and tertiary level, continued pressure on prices because of the industry was losing money on imported crude, so OPEC liftings in fact so far between January and February has been extremely low, the Middle East economic survey suggesting it might be as low as 50 million barrels a day in early February.

I have no way of verifying those numbers, so in fact in the expectations of prices softening, I think the industry and OPEC were, to use Dean Rusk's quote on the Cuban missile crisis, I think they were like two scorpions in the bottle—eyeball to eyeball, waiting for the other one to blink first, and I think the producers blinked first. Prices came down by about a dollar. A number of countries, the Russians reduced their price by $2. The Egyptians reduced their price $2, and then over the weekend the Nigerians followed.

What will happen next is very difficult to say. In order to firm up the price, let us assume, which we don't know as yet, the Gulf States will bring that price in line with the new prices that we see coming out of the North Sea and out of Nigeria. There still has to be an agreement. There has to be an agreement, new OPEC agreement, which has to be rather firm on prices and on quotas, and the industry and the West has to perceive this as a workable agreement, and they will then subsequently, if they believe it is going to be a workable agreement, they will probably reduce substantially their current stock draw.

If indeed this happens, then the new price can probably be defended. If not, then prices could weaken further. Oil consumption is likely to remain fairly soft at least through the middle of the year and strengthen thereafter when as we hope the recovery particularly in the United States firms up. There is still some uncertainty on world economic recovery. In OECD we are expecting some mild recovery but no buoyant growth as we had after the first oil shock.

The oil producers will continue to have serious current account problems. I think most will have some difficulties and may have to cut in fact their import for future services, so we are faced now at least with a price reduction. As I heard from this morning's witness, what happens beyond we don't know.

In general, we can say that the price reduction, if not too big, in other words, if it doesn't come as a shock but gradual and manageable, then it will probably have a positive impact on the world economy. The world economy, however, will not adjust as easily if that will come as a big shock. The economy is fragile and needs to be treated with care.

The impact on investment again depends on what happens, to what extent prices will decline, but if prices were to decline substantially, then it may have a very deleterious impact on investments for future sources of energy which, as I indicated before, the investments made after OPEC, had a very positive impact on reducing oil demand now, so if we don't make the investment now we may be faced with some very difficult period later on in the decade.

There is a popular notion that oil prices will collapse. We have heard the depressed stories—$13, $15, based on the economic models of the marginal I think cost of production. Many say it is inevitable.

I don't think it is inevitable. For many decades oil prices were administered. Before we had OPEC we had the famous Texas Railroad Commission registering prices, and there is no reason why the many vested interests that exist in the energy industry will not manage at some point to control the price of oil from slightly to much.

Will it happen, Mr. Chairman? That is very difficult to say. I think it will be very speculative. I would like to finish my testimony by quoting just two sentences from I would say the dean of the European oil economies, what he has said on this topic, Dr. Paul Frankel.

Dr. Frankel says, "If commonsense prevails, war would not break out since it can be proved that with very few exceptions they are counterproductive and that any new adjustment could have been achieved without bloodshed and destruction if only the parties had the long-term interest sufficiently at heart," yet wars keep breaking out through lack of communication and patience or exaggeration of the protagonists and the assumption that the adversary will take things lying down. By mutual understanding there is a short circuit and a fuse blows and he makes that a connection with where we are today, but according to all rules of economic sense, OPEC should be able to survive since any of the likely alternatives would be worse for virtually all of its members, and as we shall see, for most other interested parties as well.

Still, in the present circumstances it is not all together impossible that the obvious divergences of economic and political stance of the members could lead to a complete breakdown. If the people directly involved were to realize fully that they cannot go too far without only rocking the boat but also letting it capsize all together, the worst could be avoided, but one cannot be too sure.

[The prepared statement of Dr. Franssen follows:]

Current Oil Market Outlook

Statement of Dr. Herman Franssen
Head, Economic Analysis Division
International Energy Agency

Committee on Energy and Natural Resources
United States Senate
Washington, D.C.

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Introduction

Mr. Chairman : It is a pleasure to testify again before your Committee on behalf of the International Energy Agency. The assessment of current oil market developments, the topic of today's hearing, is followed very closely by the IEA. At present the short-term world oil market analysis which takes into account submissions by governments, is updated on a monthly basis at the IEA Secretariat in order to provide policy makers with timely information and analysis on changes in consumption and oil supply as well as stock movements.

Recent Oil Market Situation

I would like to discuss briefly recent developments in the world oil market and the possible impact of these developments on the medium and longer term.

Developments in the Past Decade

This year will be the tenth anniversary of the Arab oil embargo of October 1973, an event which brought about a revolution in world energy developments. It's often forgotten that a relatively small and short-lived interruption in world oil supplies in the fall and winter of 1973 led to an almost quadrupling of oil prices in a few months time. It is true that the real oil price had eroded by perhaps a quarter by 1978, but predictions by academicians and others that following the steep increases in 1973-1974 oil prices would collapse never materialised.

The 1973-1974 oil crisis caused the major consuming countries in the industrial world to group in the International Energy Agency at the initiative of Dr. Kissinger. The IEA developed a mechanism to monitor supply and demand and to allocate supply in the event of a major crisis defined as a shortfall of over 7% of its members' consumption. Member states became also convinced that in order to reduce vulnerability to supply interruptions, it was necessary to bring about long-term structural change. The energy policies put in place by Member governments in the 1970s added significantly to market forces in bringing about structural change in the energy markets of the industrial countries.

The investment decisions made then are now making a significant contribution to lowering demand for imported oil.

In the years following the first oil shock, complacency gradually set in. As late as the summer of 1978, only a few months before the Iranian revolution, a couple of studies by well-known energy analysts predicted that the occurrence of another oil shock, or major increases in the real price of oil, were highly unlikely at least through 1985. Hence, few were prepared for the developments in the oil market following the outbreak of the Iranian revolution in October 1978. Once again a relatively small interruption of world oil supplies for a few months caused prices to more than double in the course of a little more than a year. Those who warned at the start of 1979 that the continued unrest in Iran and the absence of action by governments on demand, would lead to price increases on the order of 50% (from $12 to $18 per barrel) were considered to be alarmist, if not actually self-serving.

Oil consumption 1978-1982

The steep price increases in 1979 did not have an immediate impact on the OECD economies. OECD economic growth still averaged 3.3%; total primary energy demand rose by about 2%, and apparent oil consumption by 1%. Part of the growth in "apparent" oil consumption was probably due to stock build at the consumer level which is difficult to measure.

The full impact of the 1979 oil price increases were felt in 1980 and 1981. While 1980 and 1981 GDP grew at just over 1% in the OECD countries, energy demand fell by 3 and 2% respectively, and oil consumption by 8% and 7%.

By mid-1981, the OECD expected a modest recovery of the world economy in 1982, with output accelerating in the second half of the year. If that had indeed happened, energy demand would have grown again and oil consumption would at worst have dropped a little. Contrary to expectation, economic activity in the year 1982 turned out worse. Instead of about 2% economic growth as expected by mid year, OECD GDP turned negatible at -0.5% in 1982. Lower economic activity combined with the lingering effect of 1979-1980 price increases caused energy demand to fall by another 2% and oil consumption by an estimated 5%.

While good data for most developing countries' energy and oil consumption usually lag by about two years, spot checks of a couple of major non-OPEC developing countries suggest that oil consumption in this large and diverse group of countries has stagnated since 1980, despite estimated 1980-1982 economic growth of 3-3.5% per annum. Lower economic growth, higher internal prices for oil, foreign exchange problems and fuel switching, all contributed to these developments. In contrast to recent experience in the industrial world, there is, however, no indication yet of any significant change in the basic relationship between energy and economic growth in the developing countries.

Declining oil consumption in the OECD coupled with stagnation in LDC oil demand has resulted in a fall in non-Communist world oil consumption from 52.1 mbd in 1979 to 45.5 mbd in 1982.

Table 1

U.S., OECD and World Oil Consumption 1978-1982

(mbd)

	U.S.A.	Other OECD	Total OECD	Total Free World(1)
1978	19.3	22.1	41.4	51.3
1979	18.7	23.0	41.7	52.1
1980	-	-	38.8	49.6
1981	16.2	20.7	36.9	47.7
1982 (est.)	15.1	19.4	34.5	45.5

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(1) Including processing gain and additional government-owned stocks.

It is very difficult to separate the impact of lower economic growth from other factors contributing to lower oil demand such as prices, exchange rate fluctuations, conservation, belt tightening, fuel switching, government policies and stock changes. Each one of the factors of course contributed to the decline.

Economic Growth

The 1979/80 oil shock was similar in magnitude to the first oil shock, or some 2% of OECD GNP. It struck before the OECD countries had fully recovered from the first shock. Inflation re-acclerated, current account deficits increased, public sector deficits swelled, and unemployment rose further. Taken together, these four "imbalances" presented a greater problem for policy in nearly all economies than in any previous post-war cycle.

Faced with these problems, the policy imperatives this second time were judged different from those after the first shock. Rather than seeking to support demand in the short-term, the over-riding concern, felt by virtually all OECD governments, was to contain the inflationary impulse and to prevent, through a rapid adjustment of real wages, the price shock from becoming built into the domestic wage/price spiral.

There was also considerable concern over budget deficits, partly because of a fear that their financing might crowd out productive investment, but also it was felt that the growing share of the public sector in general, would be an obstacle to future growth.

The result was a shift to a rather restrictive fiscal and monetary policy. The combination of a more restrictive fiscal and monetary policy by most OECD governments contributed to the reduction in economic growth after 1978, and in particular in 1981. According to estimates by OECD economists about half of the reduction in GDP in the OECD between 1979 and 1981 was directly due to oil price increases, and the other half due to fiscal and monetary policies designed to contain inflationary pressures. The combined impact has been severe.

The real cost of the two price shocks can be measured in terms of higher inflation, unemployment and lower economc growth as shown in Table 2. The long-term effects of the 1973-74 price shock appear to have been affecting the course of the economy until 1978. By 1976 the inflation rate had slowed down; GDP has resumed growth, and unemployment had more or less peaked. Thus, the impact of the first oil price shock appears to have generated adverse trends for the OECD economy which heavily influenced the economy for 3-5 years. However, it took about five years until the OECD Current Account Balance became positive and reached the same level as in 1973.

The same pattern of adverse trends was repeated after the 1979/80 price shock. The big difference, however, was that the second leap in prices was imposed on an already high level of oil prices. Thus the impact on the economy was more severe and more protracted. At the present time (almost three years after the beginning of the second oil shock), there is no visible sign of a major economic upturn or slowing down of the unemployment rate in the OECD. The only relief is that inflation rates have at least been moderated though this has occurred through policies which also produced high interest rates and undoubtedly slowed economic growth.

Table 2

OECD Economic Indicators and the Price of Oil

	% Change in the cost of landed crude oil	% Change in Consumer prices	% Change in real GDP	Unemployment (millions)	OECD Current Account Balance ($bn.)
1973	37.7	7.8	6.1	11.3	10
1974	211.1	13.4	0.7	12.2	-25
1975	2.5	11.3	-0.2	17.4	0
1976	6.9	8.7	4.8	18.5	-18
1977	7.1	8.9	3.8	18.3	-24
1978	1.0	8.0	4.0	18.7	10
1979	37.8	9.8	3.1	18.9	-28
1980	70.0	12.9	1.2	21.4	-69
1981	10.3	10.6	1.5	24.7	-31
1982	-8.4	8.5	-0.5	30.3	-39

The cumulative loss of real income to OPEC countries, due to the terms-of-trade deterioration, amounted to an estimated 2% of GNP in 1980 and 1981. The GDP loss caused by the net decrease in OECD aggregate demand (or OPEC increased savings) appears to be over 3% of 1980 GDP and 4% of the 1981 GDP. Furthermore, tightening of fiscal and monetary policy in reaction to oil-induced inflation, added also to the reduction in aggregate demand. The combined output, terms-of-trade and policy-induced loss is estimated to be around 5% of OECD GNP in 1980 and nearly 8% of GDP in 1981. By 1981, the total loss in real income in the OECD arising from higher oil prices of 1979-1980, can thus be estimated at more than one trillion dollars, or about $1500 for every man, woman and child in the OECD countries.

Table 3

Real Income Losses to OECD Countries due to 1979/80
Oil Price Rise and Policy Response
(percentage of OECD's GNP)

	1980	1981
Due to:		
Terms of trade deterioration	1 3/4	1 3/4
GNP loss:		
* OPEC-induced extra saving	3	4 1/4
* OECD-induced	1/4	1 3/4
TOTAL	5	7 3/4

The basic significance of the two oil shocks is that shocks on the supply side of the economy are difficult to absorb in the short and medium term. Energy and oil enter virtually all industrial and household activities. In the short run, energy and oil are not readily substitutable, so that even a small disruption in the supply of oil exacts a very large economic and social cost.

The transition from low cost energy to high cost energy involves a number of adjustments in the world economy that can take place only gradually. Fixed capital equipment in industry and energy using appliances in the household sector are not easily changed in the short to medium term. Oil price increases in the past have come about in the form of sudden shocks. As a result the world economy has been a lot slower in adjusting and the recessionary waves were much longer.

Oil Prices

The average CIF cost of crude oil in the OECD countries rose by about 136% if expressed in U.S. dollars(from $14.02 in 1978 to $33.20 in 1982). In the U.S. average annual refinery acquisition cost of imported crude oil peaked at about $37 in 1981 and dropped by about 11% to $33 per barrel at the end of 1982. In other OECD countries, however, the price continued to rise in 1982 due to dollar appreciation.

In local currencies 1982 (through November) Arab Light oil prices increased by 6% in the U.K. and West Germany, 13% in France and 20% in Japan.

Interfuel Substitution

Substitution of other fuels, primarily coal and nuclear for oil, increased significantly throughout 1978-1982. Coal use grew by 17% and nuclear power by 34%. By contrast, overall primary energy use declined by 6.3% over the same period.

Government Policy and Consumer Expectations

Persistent efforts by Member governments to restrain demand for imported oil through improvement of energy efficiency standards, oil decontrol in the U.S., major efforts to promote interfuel substitution, and dissemination of information concerning the problem of oil supply and prices have added to the reduction in oil demand in the OECD.

Special Factors

Weather and consumer destocking have also played an important role in understanding growth and reductions in oil consumption since 1979.

It is clear that the panic of 1979 caused consumers in all OECD regions to build stocks at least through 1980. Following the decline in oil consumption and the perception that no new shocks were likely to occur soon, consumers destocked in 1981 and 1982. The full magnitude of consumers destocking is not known, but it is estimated to have been quite sustantial.

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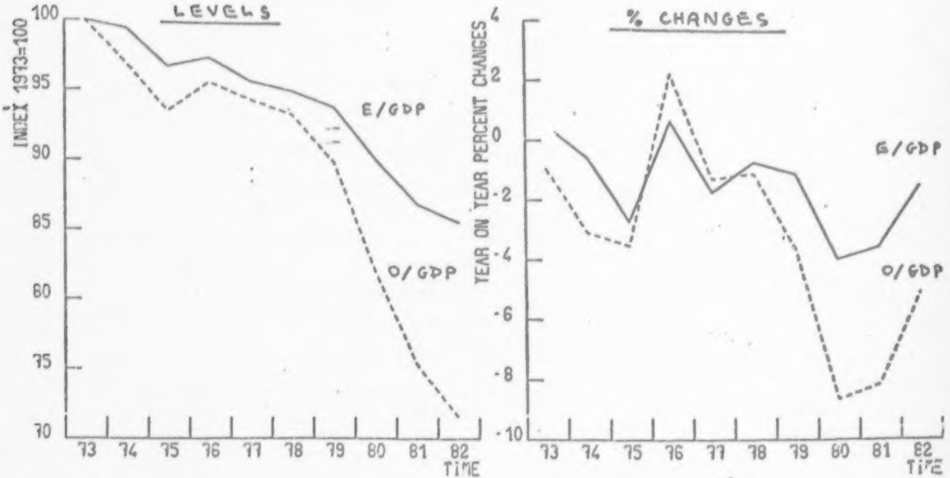
The cold weather in the first quarter of 1979 exacerbated the already tight oil market by forcing a substantial stock draw at a time when liftings outside of Iran were reaching a technical maximum. By contrast, the much milder than expected 1982/83 winter caused a reduction in projected oil consumption in late 1982 of more than half a million b/d.

Energy/GDP Ratio

While conservation and fuel switching continued through 1982, recent data suggest that energy and oil use per unit of GDP has stopped declining as fast as it did in the 1980-81 period. In 1982 when GDP in the OECD declined by -0.5% (the steepest in the last two decades) energy and oil consumption declined by -2% and -5% respectively. By contrast, when in 1980/81 GDP growth was positive (1-1.5%) energy and oil consumption declined annually by -2.5% and -7.2% respectively. In the transportation sector, oil use per unit of GDP actually increased again in 1982. There are some signs therefore that substution away from energy and oil is weakening (see figure I).

Figure 1

OECD REGION ENERGY/GDP AND OIL/GDP RATIOS



Oil Supply 1978 - 1982

As shown in Table 4 non-OPEC oil supply will have increased by as much as 3.4 Mbd between 1979 and early 1983. While most of the growth in non-OPEC supplies has come from the North Sea and non-OPEC developing countries, in particular Mexico, other countries have also made unexpected contributions. While oil production in the US showed gradual declines prior to 1979, it firmed in the years after 1980 when oil decontrol resulted in rapid growth in development drilling. Also contrary to earlier expectations, net exports to Communist Countries actually increased between 1979 and 1983.

Table 4
Non-OPEC Oil Supply 1979 - 1982
(mbd)

	1979	1980	1981	1982	1983
OECD	14.7	14.8	15.0	15.2	15.5
Developing Countries	5.3	5.7	6.3	7.0	7.3
Net Exports Communis World	1.1	1.0	1.1	1.4	1.5
Processing Gains	0.5	0.6	0.6	0.7	0.7
Total Non-OPEC Supply	21.6	22.1	23.0	24.3	25.0

Demand for OPEC Oil 1978-82

At times of high demand for oil in the non-Communist world, market developments have depended largely on OPEC's ability and willingness to supply oil relative to demand. When the market was weak OPEC often shut in capacity rather than putting downward pressure on the price structure, while other oil producers have tended to market the full volume of their output.

As shown in Table 5. The decline in World oil demand since 1979 has reduced OPEC's share of free world oil supply from 59% in 1979 to 43% in 1982. OPEC's share is not likely to drop any further in the near future.

Table 5

Free World Demand for OPEC Oil, 1979 - 1982

(mbd)

	1979	1980	1981	1982
Free world oil consumption	52.2	49.6	47.7	45.5
Stockbuild (or draw)	1.0	0.1	(1.2)	(1.5)
Total Oil Demand	53.2	49.7	46.5	44.0
Non-OPEC Supply	21.6	22.1	23.0	24.3
Demand for OPEC Oil	31.6	27.6	23.5	20.7
Percentage of World Supply	(59)	(56)	(49)	(43)

Following the first oil shock, demand for OPEC oil fell 11% between 1974 and 1975, but, a year later demand for OPEC oil, had been restored to the 1973 level. By contrast, demand for OPEC oil fell 13% in the first year following the second oil shock, but continued to decline in the following year to a total of 34% and between 1979 and 1982.

The 1983 Oil Market Outlook

The year has only just started and it is still too early to speculate on developments for the full year. While the OECD expects an economic recovery during the second half of the year, the recovery is projected to be modest compared with previous post-war recovery periods. Overall OECD GDP is estimated to grow by 1 $^{1}/2$% this year, implying a 2% growth for the United States.

Assuming such a modest recovery, the IEA projects a small drop in overall energy demand of 0.5-1.0%, reflecting the continuing but gradually declining impact of the 1979/80 energy price increases. Short of a major price cut, oil consumption could decline, another 1-3%, as shown in Table 6.

Table 6

Quarterly Forecast of World Oil Demand and Supply, 1981-1983

(mbd)

	1981					1982					1983 (est
	Q1	Q2	Q3	Q4	Year	Q1	Q2	Q3	Q4	Year	Year
Demand											
U.S. (incl. proc. gains)	16.8	15.8	16.0	16.0	16.2	15.9	14.9	14.8	15.1	15.1	15.2
Other OECD (incl government owned stocks)	22.8	19.2	19.4	22.0	20.7	22.0	18.6	18.6	18.7	19.4	19.4
Developing Countries	10.7	10.7	10.8	10.8	10.8	10.6	10.6	10.6	10.6	10.6	10.7
Total	50.3	45.7	46.2	48.8	47.7	48.5	44.1	44.0	44.4	45.5	45.3
Supply											
U.S.	10.2	10.2	10.2	10.2	10.2	10.3	10.3	10.3	10.3	10.3	10.3
Other OECD	4.9	4.7	4.6	4.9	4.8	4.8	4.9	4.9	5.0	4.9	5.4
Non-OPEC LDC + Net CPE Exp.	7.3	7.7	7.4	7.4	7.4	7.9	8.2	8.6	8.9	8.4	8.8
Processing Gain	0.6	0.6	0.6	0.6	0.6	0.7	0.7	0.7	0.7	0.7	0.7
Total Non-OPEC	23.0	23.2	22.8	23.1	23.0	23.7	24.1	24.5	25.0	24.3	25.1
Stockbuild (or Draw)	(1.5)	1.7	(1.6)	(3.6)	(1.2)	(4.1)	(1.4)	(0.2)	(0.6)	(1.2)	N.A.
To Balance											
Demand for OPEC oil (incl. NGL)	25.8	24.2	21.8	22.1	23.5	20.7	18.6	19.3	20.5	19.7	N.A.
IEA stocks on land (at end of period)											
Level (millions barrels)	3358	3458	3481	3412	3412	3221	3167	3121	3060	3060	
Days of Forward Consumption	106	108	101	101	101	105	105	104	98	98	

The upward effects of modest economic recovery and unchanged or slightly reduced oil prices are expected to be mitigated by the continuing responses to earlier large price increases and the weakness in the recovery of the so called "smokestack" industries. If, however, the economies of the industrial countries - spearheaded by the US - recover earlier and stronger than expected, overall 1983 oil consumption would probably cease to decline.

Winter 1982/83 demand for oil has, so far, declined sharply due to unusual mild weather in North America, Europe and Japan between October and late January. Some industry sources estimate that the milder winter could reduce oil consumption in the winter season by close to one million bd. In addition, industrial production in the largest oil consuming countries continued to decline in the Fourth Quarter of 1982. Together, the mild weather and the continuing recession has substantially reduced winter demand for products at the middle and heavy end of the barrel. This happened at a very early stage in the Winter, and continued so far through January, several months before the summer season which traditionally has been the period of lower consumption. The key to stability in the oil market through to the mid summer lies on the supply side and in particular, with OPEC.

Oil Supply

Non-OPEC oil supply had continued to grow since 1979 and is projected to increase again by close to one million b.d. in 1983 (see Table 6). Much of the growth is projected to come from the North Sea, and a member of non-OPEC developing countries. In contrast to expectations in previous years, net exports of oil and products from the Communist Countries is expected to remain unchanged from last year's level. The continued growth in non-OPEC oil production reflects active exploration and development programs following the steep oil price increases of 1973/74 and 1979/80. Moreover, while more than one third of OPEC's production is shut in because of pricing, agreements, the Iran-Iraq War, little non-OPEC oil is shut because their prices more closely reflect current market conditions.

Stocks

Overestimation of oil demand in both 1981 and 1982, largely due to expectations of an early economic recovery, resulted in higher levels of commercial stocks than industry deemed desirable. In spite of significant stock draw downs in both years, IEA on land stock remained at close to 100 days of forward consumption throughout this period because of steadily declining consumption.

While weather reports in the Autumn of last year predicted an unusually cold winter, the months of November through January turned out to be unusually mild. This in turn reduced consumption and left industry with higher than expected commercial stocks as at the end of the year. Market expectations will determine to what extent stocks will be drawn in 1983.

OPEC's failure to agree on individual country quotas and pricing differentials at the January Geneva meeting as well and developments thereafter have raised industry expectation that prices will come down. Recent estimates of OPEC production of 16 Mbd or less in the trade press suggest a substantial stock draw is occuring in early 1983. This could of course come to a halt if OPEC agreed on Country quotas and pricing, and if the market anticipates an agreement that holds.

The extent and duration of any stock draw will depend on market expectations and the size of the so called stock "cushion", i.e. the stocks over and above working level and legal requirements. At currently expected consumption in the OECD countries, on land stocks (public and private) were estimated at 98 days of forward consumption on January 1, 1983.

The market outlook in 1983 remains highly uncertain and even though we have been told by some oil economists ever since 1973/74 that oil prices would collapse, an oil price collapse is not expected since it is not in the interest of major producers. What seems more possible in the current situation is a modest reduction in oil prices, with some assurance of a substantial period of price stability in nominal terms. Such a development would give a badly needed boost to the world economy once the recovery sets in.

Of course, one cannot entirely exclude the possibility of a breakdown in communication between producers resulting in a more substantial price reduction. In contrast to those who believe that oil prices would remain low for a very long time following such a developement, one could argue that it could create the conditions which could once again lead to a repetition of the events of the 1970's.

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In the industrial sector, oil has become more and more the marginal fuel. Significant lowering of the price could result in substantial fuel switching from gas and coal back to fuel oil. Moreover, investments would be postponed, not only in esoteric energy sources, but in high cost oil and gas developments as well. Much lower oil prices would probably also cause a reduction in oil exploration within OPEC, thereby gradually reducing spare capacity. Responsible policymakers, regardless of their specific area of assignment, must look beyond the events of the day to anticipate possible consequences for later on.

Medium and Longer Term Oil Market Developments.

With respect to the next few years much will depend on the extent to which the reduction in oil consumption since 1979 is a cyclical phenomenon caused largely by the recession and belt tightening, and to what extent it is structural, (i.e. caused by changes in industrial output, conservation and fuel switching).

Our current estimates indicate a slight further reduction in oil consumption in 1983, but the turning point may be near. A real recovery of the OECD economies in 1983/84 could, add an estimated one million b.d. to demand. Pricing developments in the near future may of course have a major impact on the economic recoveries and on oil demand expectations.

Assuming modest OECD economic growth of slightly below 3%, in 1984/85, OECD oil demand may remain around 35 Mbd by 1985. With consumption in the developing countries expected to grow from 10.7 Mbd in 1982 to about 12 Mbd in 1985, overall non-communist oil demand is now estimated at about 47 Mbd. Non-OPEC oil production is projected to grow to about 25 Mbd, leaving a demand for OPEC oil in 1985 of about 21-22 Mbd.

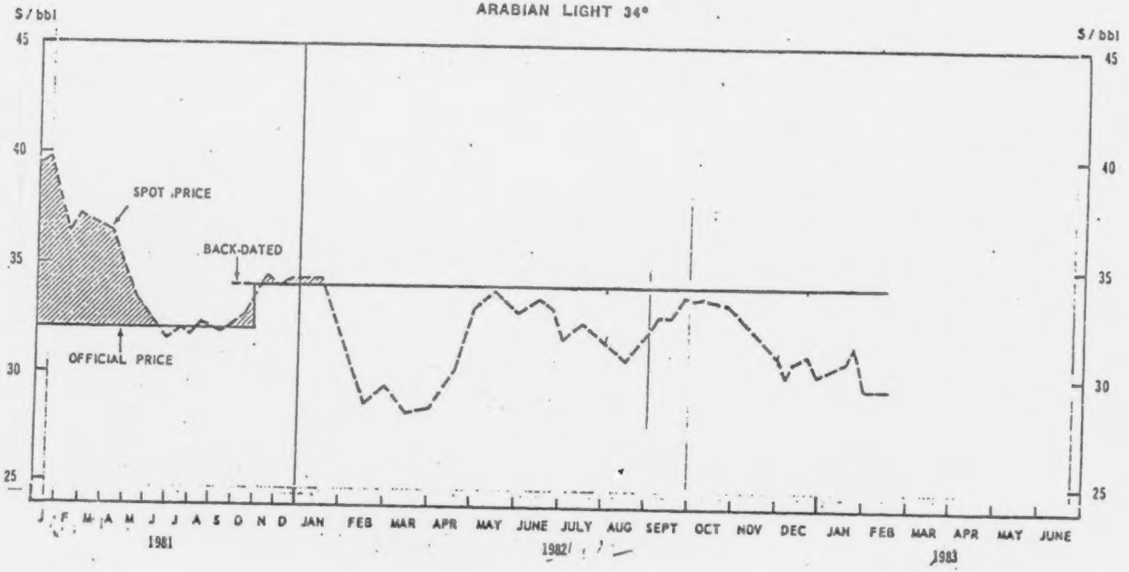
Post 1985 Developments

Uncertainties multiply when analysing the longer term world oil outlook. Too little is known yet about trends in industrial restructuring and about long-term price elasticities to determine how much additional conservation can be expected in the years to come based on either today's or somewhat lower oil prices. In the long run there are also numerous uncertainties on oil and gas production prospects, coal penetration, synfuels, renewables and nuclear energy prospects. Even more difficult is to determine the economic prospects of the newly industrialised countries of Asia and Latin America and the impact of industrialisation in those countries on oil demand.

Even if prices were to remain unchanged in today's dollars for the remainder of this decade, the IEA projects a gradual tightening of the oil market by the late 1980's in its recently published World Energy Outlook. If one assumes somewhat lower medium term economic growth in the newly industrialised countries due to the current debt burden, the world oil market is still expected to tighten around 1990 or a few years thereafter. The recession in the OECD and the slower growth in the developing world will have an energy demand reducing effect in the sort and medium term, but at the same time investment decisions for future energy supplies are being postponed. A tightening of the oil market by the late 1980's may seem remote when we are struggling with the current major economic problems. We should keep in mind, however, that the root cause of the economic problems post 1973 was related to the two oil shocks. Energy supplies for the mid to late 1980's are to a large extent determined by investments already made. To insure that events of the 1970's will not repeat themselves in late 1980's or early 1990's new investment decisions cannot be postponed for too long.

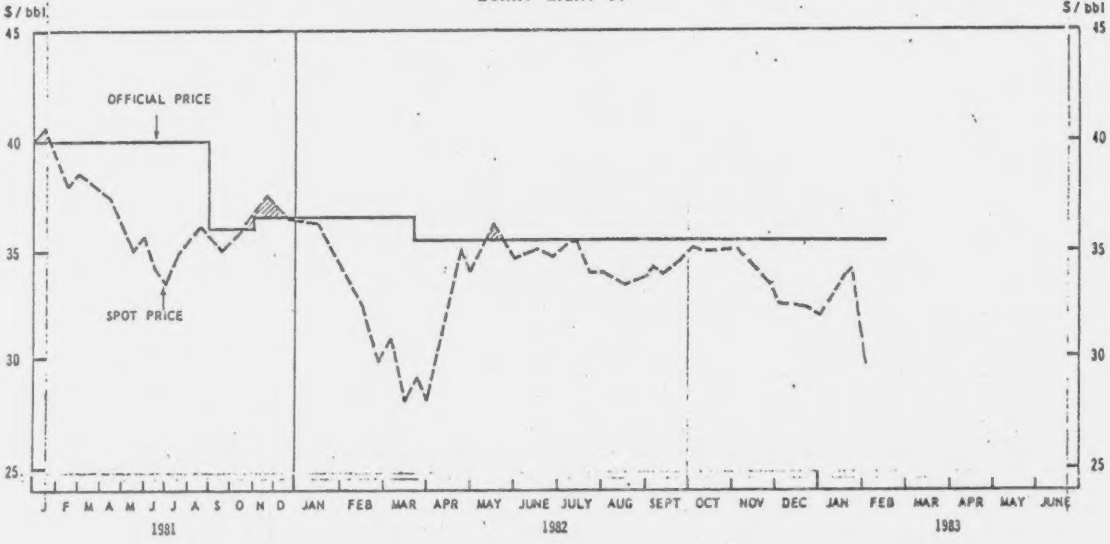
DIFFERENCES BETWEEN OFFICIAL AND SPOT PRICES
1981-1983

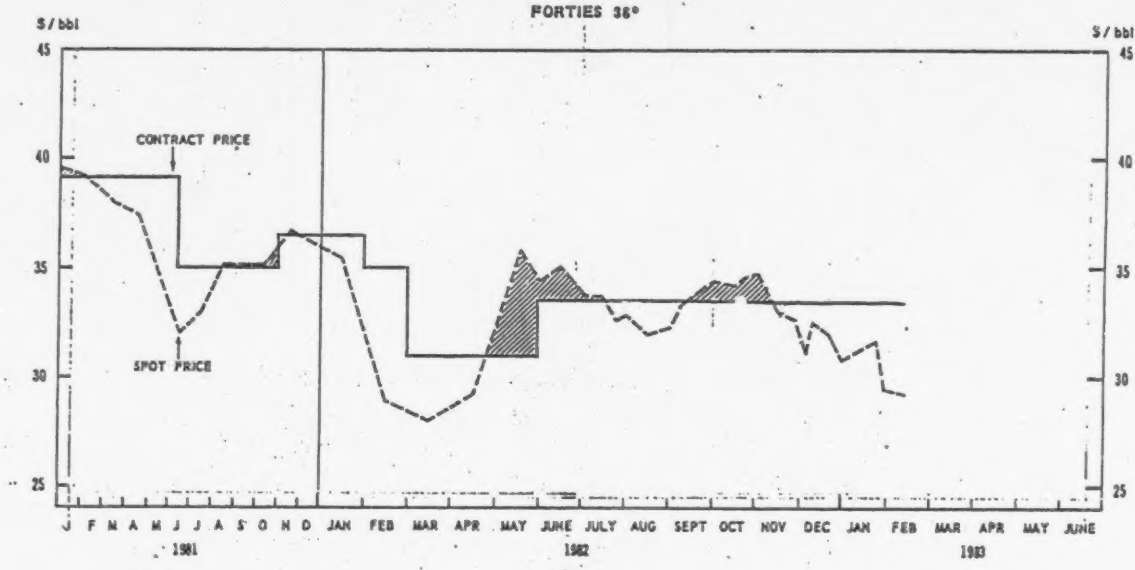
ARABIAN LIGHT 34°



DIFFERENCES BETWEEN OFFICIAL AND SPOT PRICES
1981-1983

BONNY LIGHT 34°



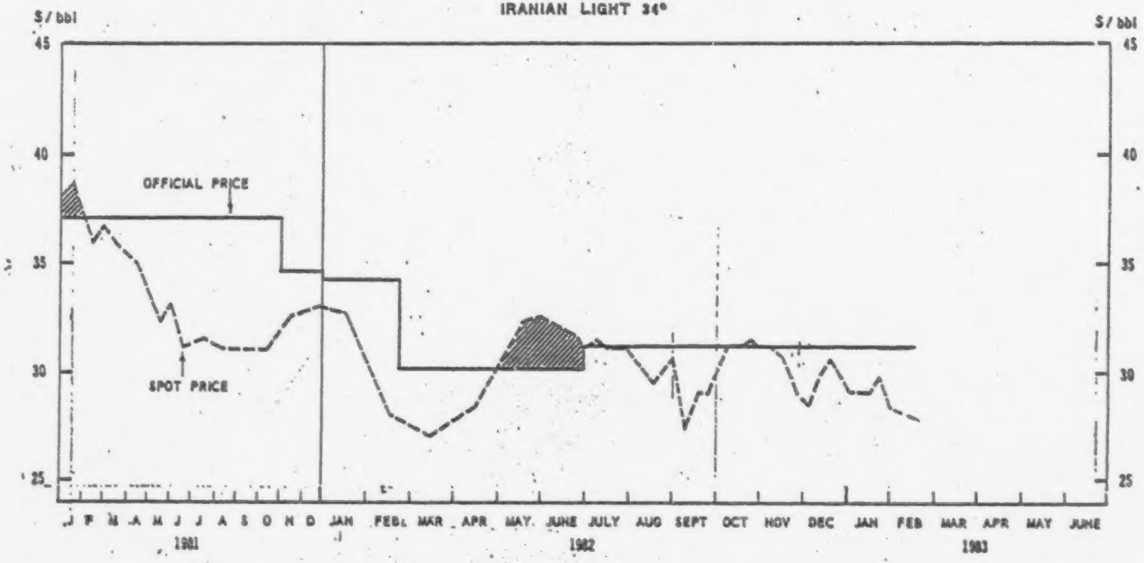


DIFFERENCES BETWEEN CONTRACT AND SPOT PRICES
1981 - 1983

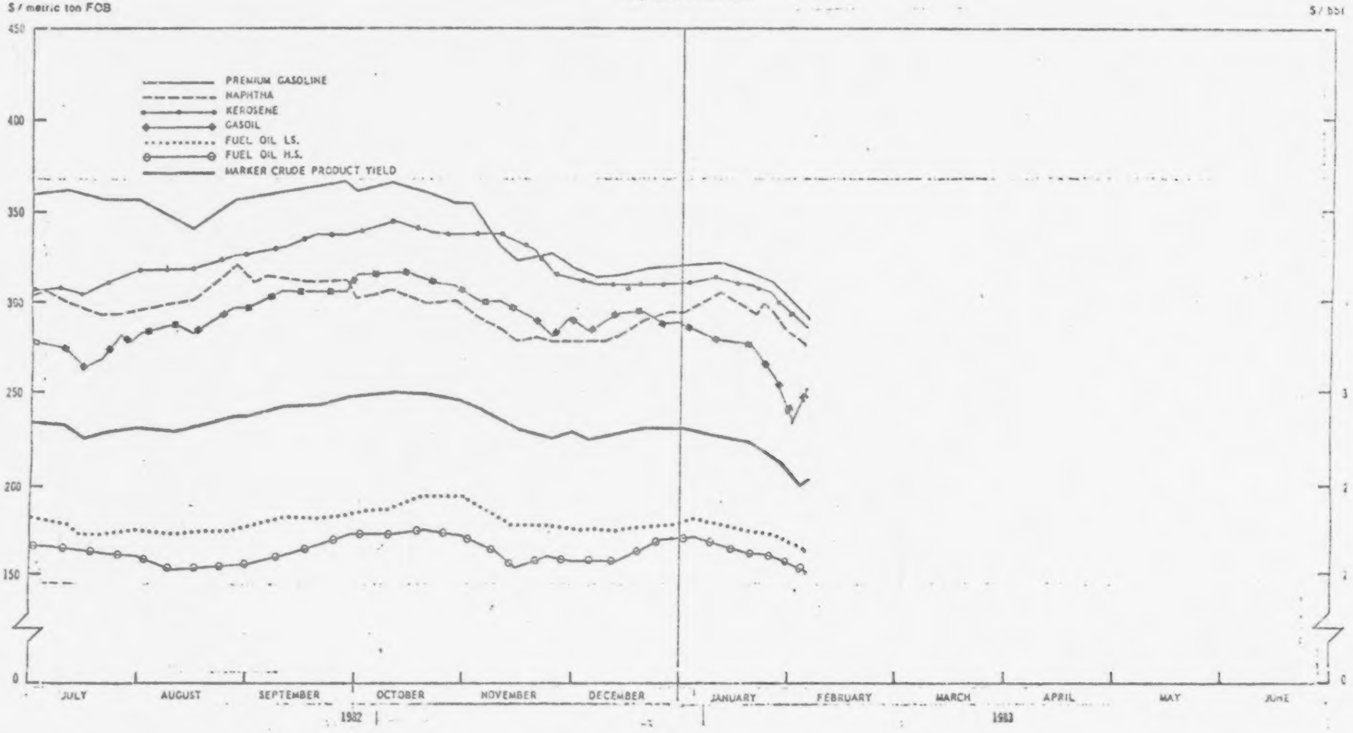
FORTIES 36°

DIFFERENCES BETWWEN OFFICIAL AND SPOT PRICES
1981-1983

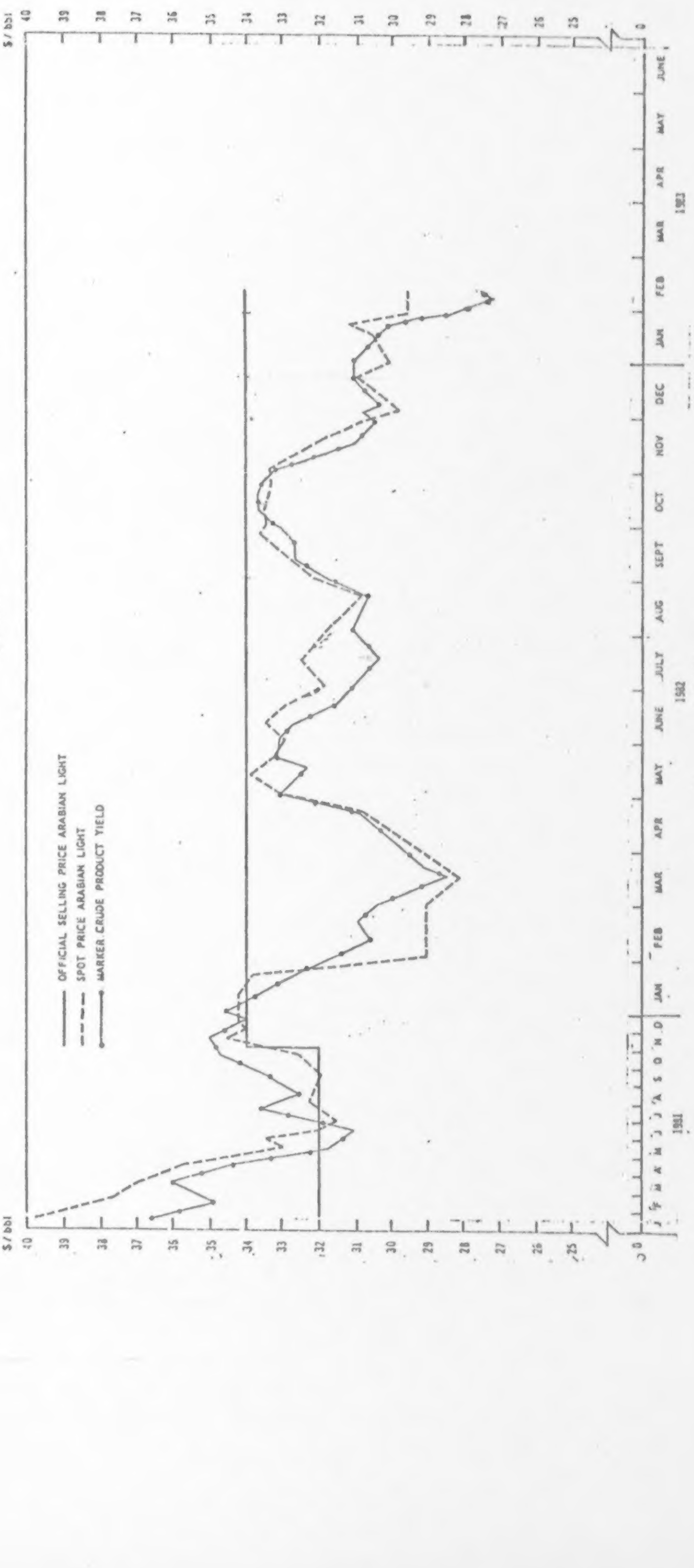
IRANIAN LIGHT 34°



PETROLEUM PRICE DEVELOPMENTS IN ROTTERDAM.
July 1982 - June 1983



AVERAGE PRICES FOR CRUDE AND PRODUCTS
1981-1983



The **Chairman**. Thank you very much for your statement. As usual, it is very constructive and very helpful to us.

Do you expect the current oil glut to persist for the rest of the decade?

Dr. **Franssen**. That would very much depend, Mr. Chairman, on what is going to happen to the world economy, how fast we are getting out of the current slump in the industrial countries, and to what extent economic growth will recover.

Second, it will depend on how quick we will solve the debt burden issue and get the developing countries back through sustained economic growth because I see that as the strongest source of future rise in our demand.

Third, it is a matter of prices. If prices were to remain rather firm, I think between conservation and fuel switching we are well on our way to keeping oil demand fairly stable in the industrial countries, but the more prices were to fall now, the more of a challenge there is for fuel switching back into oil from coal, from gas, and fourth, major reduction in investments. We have seen it in the synthetic fuels industry. We have seen it in our deep gas and a lot of other sources of energy where investments are beginning to come down quite substantially, so on balance I would say that the more the price drops, the bigger are the chances that we will end up with some potential steep price escalations in the late eighties or early nineties.

The **Chairman**. You mentioned in your testimony, again in your answer just now, that investment decisions are being made now. In your testimony you refer to the fact that investment decisions during the seventies are now making a significant contribution to lowering demand for imported oil, and you just now made reference to the fact that the expectations of the future oil crises are leading to changes in investment decisions now.

Are there other examples to which you could point about investment decisions now that will affect the demand for imported oil in the next decade?

Dr. **Franssen**. Well, in the first place, Mr. Chairman, I think on the gas side, I think if the perception is that oil prices will continue to drop, I think efforts on deep gas, for new deep gas will decline very quickly. The Alaskan pipeline may be postponed further; if it receives much lower prices, a lot of marginal oil fields in hostile environments like the North Slope may not be produced as quickly.

The same is true I can say for the modular fields in the North Sea, for gas fields in the North Sea, for coal investments in Europe. Coal is much more expensive because it is imported for all forms of esoteric fuels which tends to be costly, and of course, for investment in OPEC itself because if they are going to go through a couple of years of, numerous years of relatively low income compared to what they were expecting, they may not keep up their investment and their productive capacity may drop as well, so I think if that certainly continues we may well see a very substantial drop in the investment climate.

The **Chairman**. Would you indicate to the committee what studies the IEA currently has underway to assess IEA member countries' vulnerability to oil and gas imports and what the status of those studies is at the present time?

Dr. **Franssen.** There are two studies underway, Mr. Chairman. One deals with the overall issue of energy vulnerability—oil, gas, coal, nuclear, but largely relating to oil and gas.

Then there is a separate study going on on natural gas, the security aspect, which mainly relates to the European gas situation and specifically to the potential technical and political interruptions of the gas supply in the European market. Most of those studies will be completed some time in the spring, Mr. Chairman.

The **Chairman.** Dr. Franssen, in your testimony you pointed out in figure 1 that oil gross domestic product ratio has fallen much further than the energy gross domestic product ratio.

Wouldn't this suggest that the rise in oil prices has resulted more in fuel switching than in energy conservation?

Dr. **Franssen.** I think, Mr. Chairman, it is a combination of the two. It is a combination of actual conservation, belt tightening, and fuel switching. It is very difficult. The industry is struggling with it. We are struggling with it to find out how much is really belt tightening. If you see people from say between 1979 and 1981 substantially reducing the number of miles they drove that car, I would think that is a belt-tightening issue. If gasoline becomes cheaper, they may go back to their old habits and drive as much as they did prior to the oil shock.

On the other hand, inflation is a more permanent fixture. Some of the fuel switching may also be temporary, as you indicated, Mr. Chairman, this morning, with fuel switching in the utility sector because with the economy in a very deep recession, particularly for the smokestack industries, very, very deep recession in the smokestack industries indeed, that may mean that once we get out of it that the marginal fuel could very well be oil and that we could see very substantial reduction in oil demand in that particular sector of the economy, and if we assume that that sector will come back to at least part of its previous glory.

The **Chairman.** Thank you very much. Senator Johnston?

Senator **Johnston.** Thank you, Dr. Franssen. Dr. Franssen, you have heard the Department of Energy testify here that the world surplus of oil productive capacity is in the neighborhood of 10 million barrels a day in the free world.

Do you agree with that figure?

Dr. **Franssen.** Yes, Senator.

Senator **Johnston.** You think it is 10 million barrels a day?

Dr. **Franssen.** Yes, sir.

Senator **Johnston.** And what did you see as the trend with respect to the relationship between capacity and demand throughout the rest of the 1980's?

Dr. **Franssen.** Senator, if we were to get robust economic growth rate, not even as high as we had in the sixties but say 3 percent for the industrial countries, 4 to 5 percent in the developing countries, we would expect that some time by the late 1980's, certainly by the early 1990's, the demand for oil would again be very close to what the producers are able and willing to produce.

That is based on an assumption of oil prices say around the $30 mark. If prices, however, were to weaken dramatically as some people suggest, then you may see more fuel switching back into oil and it may come earlier.

Senator JOHNSTON. I don't understand how with prices at $30 you are going to do away with that 10 million barrels a day excess capacity.

Dr. FRANSSEN. Well, it would come very slow, Senator, and mainly from growth in the developing countries. If they were to have growth on the 4 to 5 percent, much of that would be fueled by oil.

Senator JOHNSTON. For example, this year in the United States production, I mean demand for oil has actually been going down. The same thing is true in France and Germany.

Dr. FRANSSEN. That is correct, Senator, but it is not only on the demand side but we see, according to our projection, we see some decline in U.S. oil production the second half of the 1980's, decline in Canadian production, a decline in North Sea oil production, a decline in Russian oil production, being upset by only partially a growth in oil production in the non-OPEC developing countries, so it is a combination of lower supply and some growth in demand that would make us believe that we are beginning to see some tightening in the market again by the late eighties under prices of $30 a barrel.

Senator JOHNSTON. All right. Doctor, you say in your statement that an oil price collapse is not expected because it is not in the interest of the major producers.

By the major producers you mean the OPEC countries?

Dr. FRANSSEN. I would include all major producers, Senator.

Senator JOHNSTON. Do you mean companies or countries?

Dr. FRANSSEN. Countries and companies; I think that generally there is a perception among many in the industry that some softening in the oil price is manageable, is something that the industry itself also can live with, but if the price comes down too much, and I am really talking about much below the mid-twenties, then a lot of expensive projects in which they had invested money, continue to invest money like in arms recovery may become very unattractive.

Senator JOHNSTON. The ARAMCO companies are now paying what, $2.50 per barrel more than the spot market?

Dr. FRANSSEN. Yes. I think they are still paying around $34 to the best of my recollection.

Senator JOHNSTON. More than $2.50?

Dr. FRANSSEN. I think so.

Senator JOHNSTON. Are they paying that because it is not in their interest for prices to come down as your statement says, or is that because they want to insure their state of supply?

Dr. FRANSSEN. I think it is not so much the absolute level that they are looking at but more relative to what others are buying. They like to see, of course, this differential move so that they will not pay more for their oil than non-ARAMCO partners that may use similar-type oil.

Senator JOHNSTON. Why would it be in their interest to pay that much more than the market price when there is a 10 million barrel a day excess capacity in oil in the world?

Dr. FRANSSEN. I think the reason, Senator, that they have been willing to pay more for oil is largely that they have a very long-term relationship with Saudi Arabia and they do not like to see that relationship broken. They expect, like we expect, that the oil market will firm up, at first in 1981 and that didn't come through. Then they expected it to firm up in 1982 and it didn't come through, and so they had been willing to pay that differential in expectation that it was only a temporary phenomenon, but with the recession lingering on, the pressures became too severe on them and something I think had to happen to make it possible for these ARAMCO partners to pay the same price as others are paying for similar-type crude.

Senator **Johnston**. Well, now that price is down, they are still paying more than spot; aren't they?

Dr. **Franssen**. Yes, Senator, but I think within the next few days following what happened in Nigeria one might expect some movement coming from the Arab Gulf as an indication as to what is going to happen to OPEC prices.

Senator **Johnston**. What would be your estimate as to what OPEC will do or Saudi Arabia will do with ARAMCO prices?

Dr. **Franssen**. My guess is, Senator, that an agreement will come out whereby all producers will bring their price in line with others. In other words, we will go back to an OPEC agreement with the crude prices around the new market that will probably be closer to $30 than to what it is now.

Senator **Johnston**. Do they have a new meeting for OPEC?

Dr. **Franssen**. There is no OPEC meeting scheduled at the moment, Senator, as far as I know. At least there wasn't until I left Paris, but I think some meetings are scheduled of the Gulf Security Council.

Senator **Johnston**. Well, how can ARAMCO today and for the next week pay $34 for Saudi crude?

Dr. **Franssen**. Well, Senator, the liftings have been down dramatically in the years following the 1979, 1980 oil shock. As you recall, Saudi Arabia production went up at some 10 million barrels a day. Out of that, the ARAMCO partners took about 7½ million barrels. Now at the moment the best guesses I get out of the public sources is that the Saudi production is somewhere between 4 and 4½ million barrels a day, out of which the ARAMCO partners, they are probably taking only about 2, so they are still lifting, but they are lifting very minimum that they need for their system.

Senator **Johnston**. And the ARAMCO partners are paying almost $3, $4 a barrel more for what? Just to preserve their long-term relationship?

Dr. **Franssen**. I think to preserve their long-term relationship in an expectation that prices would be realined soon.

Senator **Johnston**. Well, I am also getting at this statement of yours which I found to be very interesting that the price collapse is not expected because it is not in the interest of the major producers; that is, ARAMCO partners. You imply that ARAMCO partners are sort of an adjunct to OPEC and act together with them to keep prices up.

Dr. **Franssen**. I am not implying that, Senator. I would argue that there is an interest that is much broader, far broader certainly than the ARAMCO partners in total industry—the oil industry, the gas industry, the coal industry, the nuclear industry, major producers outside of OPEC—that is really a general interest in maintaining prices substantially above what it costs to produce because if you were to get the price collapse to the extent where some people in the press have been talking about, you would get a great deal of difficulty for many countries outside of OPEC and for many producers.

Senator JOHNSTON. I understand the difficulty it would create for a lot of people. What I am getting at is whether or not the ARAMCO partners are acting as aides in the free market or as aides of OPEC?

Dr. FRANSSEN. I think they are acting like good consumers. They are putting as much pressure on as they can at the moment to get prices down. That is only for a temporary period that they have been willing to pay a higher price in order not to be deprived from access to a very important source group.

Senator JOHNSTON. Thank you very much.

The CHAIRMAN. Thank you. Senator Warner?

Senator WARNER. To be more specific, do you think it is likely that Saudi Arabia unilaterally will reduce its price in the near future?

Dr. FRANSSEN. I don't think so, Senator. I think it will be as part of an agreement.

Senator WARNER. When did you think that might come?

Dr. FRANSSEN. It is hard to say, Senator. I understand there is some meeting going on of the Arab Gulf Council and maybe some things will come out of this, but I can't say.

There are no OPEC meetings scheduled at the moment as far as I recall.

Senator WARNER. Turning to the question I put to the previous witness, and that is the linkage between the need for additional credit with IMF and the world price oil supply, do you find there is a linkage there?

Dr. FRANSSEN. Not necessarily, Senator; I cannot speak here as an authority. I am not an authority on that subject. I think that the two issues are not necessarily linked.

What I hear from the banking circle is that a moderate and gradual oil price decline is manageable to the banking system, but that there are, of course, overriding problems, short-term problems related to the world debt issue which have to be overcome in two ways—one, as I already indicated, the need for more economic growth so that through trade they can then get back into a position of paying off their debts, and in the short run it appears indeed, it appears necessary that the IMF be strengthened in order to get with the private banking system and the Bank of International Settlements to lick this short-term price, serious international debt problem.

Senator WARNER. Well, I do believe this, that in that context the IMF decision will have to be scrutinized very carefully in projecting the prices of petroleum because the nations which are the most seriously affected, as you know—Mexico, Venezuela, Indonesia, some in Nigeria—all of whom in their economy are dependent on the sale of oil at these prices.

Thank you, Mr. Chairman. Mr. Chairman, I would urge the chairman and the ranking minority member to extend this hearing to include a section relating to the financial aspects of the world price of oil.

The **Chairman**. Senator Warner, I am quite willing to look at that. We have been watching the work that is being done in other committees and there are a number of such inquiries that have been made, but we will take a look at the result of those inquiries and work with you to determine whether or not another hearing would be useful and if so, we will schedule one.

Senator **Warner**. In our hearing on Friday that was an integral part of the testimony that this committee received in the closed hearing, and that is the reason that compels me to suggest to the chair that we also now have open testimony.

The **Chairman**. Thank you for that suggestion. We will work with you on it and see if it is advisable and if so, we will schedule it.

Dr. Franssen, just one further question, and this kind of bridges what Senator Warner has been asking and it is not really quite on the target of oil prices, although it is affected by it, and that is the question of how much impact on oil markets has resulted from the differing financial policies of differing governments that result in a strengthening of the dollar against other currencies?

Have you been able to measure in your studies the impact that that has had on oil consumption?

Dr. **Franssen**. Certainly, Senator, that has strengthened conservation and fuel switching in Europe and in Japan. Last year, for example, when our oil prices fell by I think about 6 percent measured in dollars, in Japan oil prices went up about 20 percent, and in some European countries it went up by, depending on the country, anywhere between 5 and 20 percent, so there has been a very substantial impact of the shifting currencies.

Now with expectations of other currencies strengthening vis-a-vis the dollar, particularly the yen and the deutchmark, it may have some reverse impact. It has helped in the 1981, 1982 years, it has helped OPEC because prices were denominated in dollars. The dollar strengthened and made life a little bit easier on the producers.

If now other currencies were to strengthen vis-a-vis the dollar as expected, it may make it a little bit more difficult on the producers, but it makes it a little bit more easy, of course, on the consumers.

The **Chairman**. Senator Melcher?

Senator **Melcher**. No questions, Mr. Chairman. Thank you.

The **Chairman**. Thank you very much, Dr. Franssen. As usual, your testimony is very helpful to us, very precise. We very much appreciate your appearance here today.

Dr. **Franssen**. It is a pleasure, Mr. Chairman.

The **Chairman**. We will next hear from a panel of three—Dr. John Lichtblau, the president of the Petroleum Industry Research Foundation; Dr. Melvin Conant, president of Conant & Associates; and Mr. Henry Schuler, director of Energy Projects, Center for Strategic and International Studies.

I want to welcome each of you before this committee. You all have appeared before us before and given us advice both in open hearings and private consultations for which we are all grateful.

We are also thankful for your willingness to appear and testify again on this important subject, and we will lead off with Dr. Lichtblau.

Dr. LICHTBLAU. Thank you very much, Mr. Chairman. May I say first of all that my testimony was written on Thursday afternoon which has been partly overtaken by events over the weekend.

The CHAIRMAN. Is that a forecast for the future as well?

Dr. LICHTBLAU. Well, I will leave it up to you whether it is a sign of the inherent instability of the world oil market or my inability to forecast for a 4-day period.

The CHAIRMAN. Thank you very much, Dr. Lichtblau.

STATEMENT OF DR. JOHN H. LICHTBLAU, PRESIDENT, PETROLEUM INDUSTRY RESEARCH FOUNDATION, INC.

Dr. LICHTBLAU. I would like to start out by discussing briefly the question everyone in industry is asking currently—how much will the world oil price decline?

Obviously the answer must be speculative. What is not speculative, however, is that the world oil price as well as the domestic price has already declined substantially over the last several years, since about mid-1981, so any further decline is a continuation of a trend that has been underway for some time. We alluded to this last when we testified before your committee on the same subject and called attention to what we then called the reverse oil shock.

The current cost of crude oil to the domestic refined, foreign domestic, is about $30, $31, something around that, which is a two and a half to three point reduction from a year ago and nearly $7 a barrel drop from the peak reached in February, March 1981. With just a nominal price adjustment for inflation, we find the real crude oil cost for U.S. refiners has dropped by about 30 percent in the last 2 years. All indications are that the world oil price decline has not yet ended. The only question is whether the reduction will continue to be relatively moderate and controlled as they have been up to now, or whether we are about to see a collapse of the entire OPEC price structure.

Which of these price reductions will occur is of major importance to the United States and the world economy, so let me briefly discuss each of them.

A moderate controlled price reduction might be one in which the average world oil price level drops to $28, $30, I would now say $27 to $29 a barrel, and remains there for some time. This would require OPEC to exercise its cartel power to retain some sort of effective control over the world oil price.

Up to now, up to last week at least, the organization seems to have managed to do this in the face of sharply falling demand for its oil. The market clearing price for oil is probably well below $20. Oil production needed to meet the world oil requirement would be available for some time at less than $20 a barrel. OPEC's ability until quite recently to sustain a price which after all adjustments for hidden discounts are made probably still averages about $31 a barrel could be taken as a sign that the cartel still functions, still controls the world oil price.

One could also argue that since loss of this control would so obviously hurt all members severely and since the principal element of maintaining it would be a firm and effective agreement among its members which had been achieved before, OPEC should be able to survive as an effective world oil price setter. Maybe it will, but there are growing signs that it may be losing control and may not be able to stem the tide of market forces moving against it much longer.

It was easy to be an effective cartel when all members were producing at 80 to 90 percent of their capacity, mostly at rising prices, but currently OPEC is collectively producing at less than 60 percent of its effective capacity with some countries under 35 percent, and prices are falling as has been demonstrated. Unity is much more difficult to achieve under those circumstances than when the going is good. Perhaps OPEC is not as effective a cartel as we all thought. We were mesmerized by its ability to raise oil prices at will and make them stick, but the market was on OPEC's side during much of that time. Substantial price increases, although not as much as OPEC had imposed, but substantial oil increases were required in the early 1970s and for some with different reasons in 1979 and 1980. Again, the Iranian production was definitely curtailed, but since 1980 market forces have been relentlessly pushing in the opposite direction. World oil demand outside the Communist countries has been declining in every year since 1979. Between then and 1982 it has dropped by 6½ million barrels a day, or 12.5 percent.

There has been nothing like it since the end of World War II, nor has the decline come to an end. We expect another drop of at least another 0.5 million barrels a day for 1983 to a level of about 45 million barrels a day for that year.

The reasons for these declines are both structural and temporary. The structural ones are the more important. Most are reactions to the excessive OPEC price increases in 1973, 1974, and again in 1979, 1981. The effect of this is that oil demand and energy demand have moved in opposite directions since the mid-1970s; from 1976 to 1982 worldwide oil consumption dropped by nearly 1 percent annually, while consumption of nonoil energy sources rose by 3 percent annually.

Other structural changes which are partly related to the oil price increase are the shift in industrial production from energy-intensive to high technology output. Thus while steel and cement production has substantially dropped in all industrial countries, the output of electronic equipment, computers, et cetera, which have low energy content, has sharply increased.

The principal temporary reason for the decline in oil consumption is the general economic recession and the unusually warm winter in North America, Japan, and Europe. Further, requirement for new supply appears to be reduced by the exceptional worldwide inventory drawdown. It is likely to be completed by midyear. This drawdown has lasted much longer than anticipated 1 year ago. Its end together with the common economic recovery, if there is one, should start raising world requirement for new oil in the second half of 1981—of 1983. I'm sorry—second half of 1983.

The recent and the currently ongoing price reduction should underpin that increase in demand because while the short-term price elasticity of oil demand is low, it is by no means zero. There is also a decline in the dollar exchange rate which Dr. Franssen talked about, and it is expected that the price reduction abroad could be fairly significant in local currencies. Thus the temporary factors could start working forward from the second half of 1983 on.

However, measured by any other than the dismal one of the last 18 months, the increase will be very modest. We expect second half 1983 requirements for OPEC crude to be about 19½ million barrels a day, or 3½ million barrels more than the first half. That is substantially less than at any year prior to 1982.

The problem for some OPEC members will be how to get from here, from the 16 million barrels a day level of today, or less probably, to the 19½ in the second half of the year without having to lower their prices by more than $3 or $4 reduction now underway in order to maintain their perceived minimum export level.

As we know, Nigeria already has gone beyond that level over the weekend. In our view, the odds are that OPEC members can hold a new price floor at around $27, $29 a barrel for some time. However, the possibility of a price collapse is a very real one and will remain so for a number of years, giving the lighter demand for OPEC oil in the 1980's.

If a price collapse were to occur, it would obviously have a positive impact on all oil consumers and a negative one on all oil producers. Since oil represents only one of many commodities used by most consumers, but is usually the principal and often the only commodity sold by producers, the negative impact would be less widespread but much more concentrated than the positive one.

The United States has an interest on both sides. It is the world's largest oil consumer and the second largest oil producer. A moderate price decline would probably not create significant disincentives to domestic oil and gas exploration, nor would it increase demand substantially. A sudden, sharp price reduction, on the other hand, would tend to do both. If that were to occur, the possibility of some action to maintain domestic exploration and conservation incentives may be considered, although one would first have to examine the inevitable market distorting effect of such measures.

In the meantime, the United States can do nothing to prevent a foreign oil price drop of whatever magnitude and should do nothing to accelerate it, but particularly since the world is already on a downward price trend which is unlikely to be reversed for some time.

One final point, and it was alluded to earlier, the risk of a major physical interruption of oil supplies from the Middle East due to unforeseen military or political events remains high. Hence the current world oil surplus provides no legitimate argument for reducing the fill rate of our strategic petroleum reserve. Perhaps in view of our reduced import dependency, 28 percent in 1982 versus 47 percent 5 years earlier, we may not need as big a reserve as we had earlier assumed, but until we reach at least the 500 million barrel level, we should not even consider slowing down our effort in this area.

Thank you very much.

[The prepared statement of Dr. Lichtblau follows:]

Petroleum Industry Research Foundation, Inc.
122 EAST 42nd STREET
New York, N. Y. 10168

Statement before the
Committee on Energy and Natural Resources
of the
United States Senate

THE NEAR TERM WORLD OUTLOOK

by

John H. Lichtblau
President

February 21, 1983

Thank you for inviting me to appear before your Committee to discuss the world oil outlook. I would like to start by discussing briefly the question everyone in the industry and government is currently asking: How much will the world oil price decline? Obviously, the answer must be speculative. What is not speculative, however, is that the world oil price, as well as the U.S. domestic price, has already declined substantially since about mid-1981; any further decline is a continuation of a trend that has been under way for some time. We alluded to this last April when we testified before your Committee on the same subject and called attention to the "reverse oil shock".

The current cost of crude oil (foreign and domestic) to U.S. refiners averages probably around $30.50-31.00/Bbl. This is a $2.50-3.00 reduction from a year ago and a nearly $7 drop from the peak reached in February-March 1981. If we adjust this nominal price drop for inflation we find that the real crude oil cost to U.S. refiners has dropped by about 30% in the last two years. All indications are that the world oil price decline has not yet ended. The only question is whether the reductions will continue to be relatively moderate and controlled, as they have been up to now, or whether we are about to see a collapse of the entire OPEC price structure. Which of these price reductions will occur is of major importance to the U.S. and the world economy. Let us therefore briefly discuss each of them.

A moderate, controlled price reduction might be one in which the average world oil price level drops to $28-$30/Bbl and remains there for sometime. This would require OPEC to exercise its cartel power to retain some sort of effective control over the world oil price. Up to now the organization seems to have managed to do this in the face of sharply falling demand for its oil. The current market clearing price for oil is probably well below $20/Bbl, i.e. all production needed to meet the world's requirements would be available for some time at less than $20. OPEC's ability to sustain a price which, after all adjustments for official and hidden discounts, probably still averages at least $31/Bbl, could be taken as a sign that the cartel still controls the world oil price. One could also argue that since loss of this control would so obviously hurt all members severely and since the principal element of maintaining it would be a firm and effective agreement among the members, which had been achieved before, OPEC should be able to survive as an effective world oil price setter.

Maybe it will. But there are growing signs that it may be losing control and may not be able to stem the tide of market forces moving against it much longer. It was easy to be an effective cartel when all members were producing at 80-90% of their capacity, mostly at rising prices. But currently OPEC is collectively producing at less than 60% of its effective capacity, with some countries under 35%, and prices are falling.

As has been demonstrated, unity is much more difficult to achieve under those circumstances than when the going is better. Perhaps OPEC is not as effective a cartel as we all thought when we were mesmerized by its ability to raise oil prices at will. But the market was on OPEC's side during most of that time. Substantial real price increases, although less than those imposed by OPEC, were required in the early 1970's and, for somewhat different reasons in 1979/80 after Iranian production was indefinitely curtailed. But since 1980 market forces have been relentlessly pushing in the opposite direction. World oil demand (outside the Communist countries) has been declining in every year since 1979. Between then and 1982 it dropped by 6.5 million B/D or 12.5%. There has been nothing like it since the end of World War II. Nor has the decline come to an end. We expect another drop of at least 500,000 B/D in 1983 to a level of about 45 million B/D.

The reasons for these declines are both structural and temporary. The structural ones are the most important. Most are reactions to the excessive (both in magnitude and speed) OPEC price increases in 1973/74 and in 1979/81. Evidence of this is that oil demand and energy demand have moved in opposite directions since the mid-1970's. From 1976 to 1982 worldwide oil consumption dropped by nearly 1% annually while consumption for non-oil energy rose by about 3% annually. Other structural changes which are only partly related to the oil price increase are the shift in industrial production from energy intensive to high technology output. Thus, while steel and cement production has substantially dropped, the output of electronic equipment, computers, etc. has sharply increased.

The principal temporary reasons for the decline in oil consumption are the general economic recession and the unusually warm winter in North America, Japan and Europe. Further, requirements for new supply continue to be reduced by the exceptional worldwide inventory drawdown. Likely to be completed by mid-year, this drawdown has lasted much longer than anticipated a year-ago. Its end, together with the coming economic recovery should start raising world requirements for new oil in the second half of 1983. The recent and on-going price reductions should underpin this increase, for although the short run price elasticity of oil demand is low, it is not zero. If there is also a decline in the dollar exchange rate, as is expected, the price reduction abroad could be fairly significant in local currencies.

Thus, temporary factors could start working for OPEC from the second half of 1983 on. However, measured by any standard other than the dismal one of the last 18 months, the increases will be very modest. We expect 2nd half 1983 requirements for OPEC crude to be about 19.5 million B/D, or 3.5 million more than in the first half. The problem for some OPEC members will be to get from here to there without having to lower their price by more than the $3-4 reduction now under way, in order to maintain their perceived minimum export flow of oil.

In our view, the odds are that OPEC members can hold a new price floor at around $28-$30/Bbl for some time. However, the possibility of a price collapse is a very real one and will remain so for a number of years, given the likely demand for OPEC oil in the 1980's.

If a price collapse were to occur it would obviously have a positive impact on oil consumers and a negative one on oil producers. Since oil represents only one of many commodities used by most consumers but is usually the principal and often the only commodity sold by producers, the negative impact would be much more concentrated than the positive one.

The U.S. has an interest on both sides. It is the world's largest oil consumer and second largest oil producer. A moderate price decline would probably not create significant disincentives to domestic oil and gas exploration, nor would it increase demand substantially. A sudden sharp price reduction, on the other hand, would tend to do both. If that were to occur, the possibility of some action to maintain domestic exploration and conservation incentives may be considered, although one would first have to examine the inevitable market distorting effects of such measures. In the meantime the U.S. can do nothing to prevent a foreign oil price drop of whatever magnitude and should do nothing to accelerate it, particularly since the world is already on a downward price trend which is unlikely to be reversed for some time.

One final point; the risk of a major physical interruption of oil supplies from the Middle East due to unforeseen military or political events remains high. Hence, the current world oil surplus provides no legitimate argument for reducing the fill rate of our Strategic Petroleum Reserve. Perhaps, in view of our reduced import dependency--28% in 1982 compared to 47% in 1977--we may not need as big a reserve as had been earlier assumed. But until we reach the 500 million barrel level we should not even consider slowing down our effort in this area.

Petroleum Industry Research Foundation, Inc.
122 EAST 42nd STREET
New York, N. Y. 10168

Statement before the
Committee On Energy and Natural Resources
of the
United States Senate

The World Petroleum Outlook

by

John H. Lichtblau
President

April 23, 1982

Thank you for inviting me to address your Committee on the near term world petroleum outlook. It is certainly appropriate for the Committee to inquire into this subject at the present time. The world oil market is currently in the process of unprecedented drastic changes. We are actually witnessing another oil shock. Only this time it is the producers, not the consumers, who are experiencing the pain of the impact. World oil production (excluding the Soviet Bloc and China) peaked in 1979 at 51.4 million B/D and has declined in every year since then. In 1982 it is likely to be down to about 43 million B/D, a drop of 16.5% over a three year period. There has been nothing like it in the post war period. The only other extended world production drop occurred after the first OPEC oil price explosion. It lasted for two years (1974-75), during which production dropped by 9% before resuming its upward climb.

The shock of the decline has fallen primarily on OPEC which has borne all of it while non-OPEC production collectively has increased steadily since 1979. This year we estimate total OPEC crude and NGL production to average about 21 million B/D, a drop of over 10 million B/D from the 1979 level. Meanwhile, non-OPEC production is estimated to amount to 21.5-22.0 million B/D, an increase of about 2 million B/D over 1979.

The reasons for the world production drop are known. They consist of three factors: structural decline in demand due to price-induced oil conservation and substitution; cyclical decline in demand due to the general worldwide economic recession; and global petroleum inventory unloading on an unprecedented scale, due to the high cost of money, declining oil prices and the perception among buyers of readily available new supplies.

The reason for the sharper decline in OPEC oil production than in world production is twofold: 1) the physical availability of non-OPEC oil supplies increased throughout this period, and 2) OPEC and non-OPEC producers pursued different policies, particularly in the last six months. OPEC's policy was price-oriented, while that of most other producers was volume-oriented. Thus, OPEC currently maintains a substantially higher price structure than its non-OPEC competitors, but has lost substantial volume to the latter, most of whom are producing at or near capacity.

The bottom line of all this is that the average f.o.b. world oil price has dropped from a peak of $35.60*/Bbl in March 1981 to an estimated $33.00 today. Similarly, the crude oil acquisition cost of U.S. refiners has dropped from its March 1981 peak of $37.48 to an estimated $33 in March 82, a decline of 12%. The sharper decline in the U.S. refiner cost than in the world price reflects the fact that domestic crude prices dropped more than foreign prices in the last 12 months. In the previous 12 months U.S. refiner crude cost had increased by about 39%.

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*EIA, Weekly Petroleum Status Report, April 3, 1981.

The price decline, like the demand drop, is unique in the recent history of oil price movements. Certainly since the late 1960's,nominal oil prices, both in the U.S. and abroad, have only moved upwards.

Will the trends that I have just described continue in the near future? I do not think so. I believe the production, demand and price declines have all about reached bottom. They are likely to stay there for a while after which production and demand will start rising again and prices will strengthen somewhat. Underlying this prediction is our assumption that two of the factors causing the recent production drop -- recession and inventory reduction -- have about run their course. A recession is by definition the downward phase of a business cycle. A turn-around is part of the same cycle. A growing number of economists are now predicting the turn-around in the current cycle for the second half of this year, both in the U.S. and Europe. I am aware, or course, that majority views of economists are a rather weak forecasting tool but some of the signs they claim to see are quite real. Foremost among these is the impressive decline in the inflation rate, brought about in part by the drop in oil prices.

The end of the inventory reduction can be expected sometime in the third quarter. There are indications that during the first quarter of this year world oil inventories were reduced by about 4 million B/D, or 1.5-2.0 million B/D more than is normal. If this is correct, inventories at the beginning of the second quarter were some 600 million Bbls below the year-ago level. Given the declining demand and the new, much lower perception of the desired level of oil stocks, we are likely to see a further inventory reduction in the second quarter. But if we are right in our assumption that the demand decline will turn around in fall, the same will be true of inventory movements. Hence, in the third quarter stocks are likely to be built up again for the seasonal winter drawdown.

A key factor in all this is of course OPEC's willingness and/or ability not to exceed the 17.5 million B/D collective production ceiling agreed to at its recent meeting in Vienna. In the 5 weeks since the meeting it appears that OPEC production has actually been below it. We know that Nigeria has been producing less than its assigned ceiling in April. The same is apparently true of Iraq since its pipelines through Syria have been closed by the Syrian government a few weeks ago. Iraq's under-production may be offset by Iran's ability and announced decision to exceed its ceiling. But for a variety of reasons the Iranians are unlikely to exceed it by very much. Meanwhile, Saudi Arabia may possibly be producing some 500,000 B/D less than its 7 million B/D ceiling.

Whatever the exact level, OPEC's current production is less than the world would require if it were not for the inventory reduction. Thus, once this reduction is completed, the demand for OPEC oil is bound to rise by several million B/D. We expect this to occur in the fourth quarter of this year at the latest.

Beyond 1982 we see world oil demand recovering at a modest but steady rate from the decline of the last three years, partly as a result of general economic growth and partly because of the absence of real oil price increases (of which more later). By 1985 demand may amount to 49.5-50.0 million B/D which would be equal to the level reached in 1977. OPEC would share to some extent in this increase. It may be required to produce 24 million B/D of crude in 1985. This would be a substantial increase from the current year but would still be way below its annual production level during the period 1972-80 which fluctuated between 31 and 27 million B/D. Thus, throughout this period OPEC will have substantial collective excess producing capacity. Prior to 1981 this was generally not the case.

What will this do to OPEC's ability to set world oil prices? Or more broadly, can OPEC survive as an effective cartel in the market atmosphere of the next several years? Within the time frame of the first half of the 1980's, the period under discussion here, our answer would be yes, with some qualifications. During this period OPEC will of course be very different from what it was during the 1970's. The aforementioned shock effect of the impact of the price increases on oil demand, together with the increasing role of non-OPEC suppliers and OPEC's own substantial excess producing capacity have clearly reduced

OPEC's ability to determine prices and this will continue to be the case. Most OPEC oil ministers have recognized this. In fact, several have acknowledged that OPEC's pricing policy of the period 1979-80 was largely responsible for the dramatic decline in the organization's oil exports during the last 12 months.

Thus, for the time being, OPEC appears to have lost its ability to raise prices at will, as it could in the previous period, but it has probably retained its ability to protect its existing floor price level. We therefore expect OPEC contract prices to remain approximately at their present nominal level this year and next and increase somewhat (but no more, and perhaps less, than inflation) in 1984 and 1985.

In our view, this price path would be an indication of OPEC's continued strength as a price setting cartel. For the present world oil price is substantially above the level which would prevail under real free market conditions. The often quoted figure of $20/Bbl under this latter scenario seems reasonable, at least in the short run. OPEC has been able to keep the price some 60-70% above this level, in the face of a unique combination of market forces trying to depress it.

Under our price and volume assumption, OPEC's collective Current Account surplus would probably disappear by next year. However, the group's oil export earnings in 1983, with no change in prices, are likely to amount to about $250 billion. This would be a 28% increase over the $195 billion the group earned in 1979 when most members registered a significant Current Account surplus. Thus, after adjustment for inflation, OPEC's foreign exchange earnings may not be less than their requirements in 1979, a year of substantial economic growth for all OPEC members.

Of course, if there is no growth in real oil export earnings, most OPEC countries will have to scale back their economic expectations and development plans. But the predictions by some analysts that OPEC will "fall apart" because some of its members will undermine its collective price policy under the pressure of short term foreign exchange requirements, does not seem to be borne out by our calculations.

The country currently most vulnerable to this type of pressure is Nigeria. Nigeria's willingness or unwillingness to abide by its OPEC assigned quota under current conditions may be a test case of OPEC solidarity under extreme conditions. Clearly, Saudi Arabia, whose power and influence in matters of oil policy is awesome, is taking some unusual steps to strengthen Nigeria's determination to stay with OPEC.

In concluding I would like to say that all my comments assume of course no major military or political disruption of the oil flow from the Persian Gulf. This standard disclaimer could become more important than all my other comments if Saudi Arabia should become directly involved in, or affected by, some of the ominous military-political-religious developments in the region.

Thus, we are by no means home free in regards to our dependency on foreign oil, whatever OPEC's official price policy may be.

The CHAIRMAN. Thank you very much. We will next hear from Dr. Conant.

STATEMENT OF DR. MELVIN A. CONANT, PRESIDENT, CONANT & ASSOCIATES, LTD.

Dr. CONANT. Mr. Chairman, thank you for this additional opportunity. What you have heard from Dr. Franssen and from Dr. Lichtblau, I agree with. I will, therefore, speak telegraphically on a number of points which might expand upon our discussion.

The CHAIRMAN. Your entire statement will be placed in the record, and you may summarize as you see fit.

Dr. CONANT. Thank you. The fact that petroleum analysts and general economists did not predict the speed and extent of the economic decline has led to an emphasis on the unpredictability of oil and the difficulty of forecasting the matters which have concerned us.

I would put a somewhat different emphasis on this. I would say that we now generally think that we know less about the economics of energy supply than we assumed only several years ago, that the unpredictability of oil supply has really been with us for a great many years, at least since the early seventies when governments rather than the commercial considerations of companies began to assume the paramount power in attempting to determine price and volume and destination.

There are a number of things that I think we do not understand, and failing to do so, render suspect a good many of our comments. For example, the relationship between GNP growth rate and energy demand is apparently more mysterious and difficult to define than we were saying several years ago. We are not all together as sure as we were about the range of considerations which lead an investor into alternatives to oil, and you have heard repeatedly this morning about the difficulty we have in telling you whether the decline in oil demand is a result of the general economic depression or conservation, in all its respects.

Not being able to tell you what is the proportion between these, I think I would have to conclude that the possibility of a return to a situation of high dependency upon world oil imports is at least a strong possibility, but we cannot tell you this, and therefore, Mr. Chairman, your questions concerning the proportion between conservation and economic decline are entirely relevant and unanswerable at the moment.

Moreover, we still believe that certain highly prospective regions of the world will result in fresh opportunities for oil supply, but given the economic circumstances and the hesitancy about price forecasts over a number of years for oil, we cannot be certain that these prospective regions will in fact be developed. The Beauford Sea is one of the key examples.

Moreover, there have been several references by your witnesses to the fact that LDC's may account for a greater, the greater share of increased oil demand. There have been many efforts to try to relieve developing countries of this burden. None of these has proven to date to be particularly successful. I guess I am particularly bothered, Mr. Chairman, by the difficulty one has in tracking what kind of investments are being made or have been postponed or canceled or indeed disinvestments into all forms of energy.

Lacking this kind of detailed picture of what our financial community, companies included, are doing, it is very difficult to know what kind of Government policy may or may not be required. In addition to Senator Warner's request that the link between oil prices and the international financial system be examined, I would hope at some point that your chairman would begin to look at the adequacy of our information on the real investment picture within our country.

If these are some of the elements about which we are really quite sure today, let me then suggest that there are some features of the world petroleum outlook which I would describe as kind of permanent. I think first of all that our failure to discover very large additional reserves outside of the Middle East condemn the OECD world to being importantly dependent upon imports.

That same failure to discover very large reserves outside of the Middle East condemns us to continue to regard the Middle East as the most prolific supplier of the international oil barrel and the political and security implications of that are evident.

I would think, again relating to the questions about oil pricing and whose interests are involved, that rather than emphasizing all of the time prospects of decline or a drop, we should at least remind ourselves occasionally that all oil producers and exporters in and outside of OPEC have a general interest in obtaining the highest possible price for their commodity, and not perhaps to regard the current tactical moves on price as obscuring this very basic consideration. Prospects of further OPEC unity, discipline, so on, should at least be looked at in terms of the general support which OPEC would obtain from other producers and investment interests in oil for the sustaining of the price.

Furthermore, considerable attention has been given I think especially by the administration to the increased share of non-OPEC members in the world petroleum supply. It is my view with respect to that, Mr. Chairman, this is somewhat misleading. Our concern in a security sense is on the international barrel, and here OPEC supply remains far and away the largest share of international trade.

Furthermore, the spare production capacity which has been inquired about by a number of you rests almost entirely with the OPEC countries, and I think that this is an extremely important observation when one looks down the next few years at what we would all hope would be moderate economic recovery on the part of OECD, a consequent slow rising of oil demand, and insofar as that is met by imports, they will be OPEC imports.

In this regard, there has been references to the spare capacity of OPEC being 10 or perhaps somewhat more, and I have indicated in my paper that it could be as much as 20. The difference I think depends on how you gage the Iraq and Iranian capacities and whether you think over the next few years these may again be available, which is my view.

The next permanent feature about the world petroleum outlook I think is that there would be little dissent from the view that there is physical adequacy of oil reserves worldwide to meet any plausible level of increased demand. However, I would share fully with Dr. Franssen the implicit warning in his remarks that as the decade moves on, we move through it, there is this virtual certainty of economic recovery and increased demand for oil. If we do not make the effort to discover the supergiants especially outside of the Middle East, then the pressure for higher prices will be relentless and there will come to be again a race for energy alternatives. This will certainly affect oil petroleum outlook.

Again, equally certain it seems to me is that commercial considerations with which we were familiar prior to the early seventies will not again be the prime force in shaping supply. The role of Government guarantees on producers and many of the consumers, other factors, will get injected into oil decisions.

With respect to, Mr. Chairman, your continuing emphasis along with others of your committee on our vulnerability, I would join with others who have expressed gratitude for this pressure. It is and remains an acute matter. While Dr. Franssen of IEA has certainly helped put us in a better position and the likelihood of a political combined action deeply cutting world supply seems somewhat remote, there is a wholly new dimension to vulnerability which comes out of the possibility of war damage to key facilities especially in the gulf, and that kind of a development which is relatively new in the world petroleum supply should be a very major preoccupation, and I would join with Dr. Lichtblau in urging that the SPR be at least at 500 million barrels. I don't see how it could possibly be less than that.

I would share what Dr. Lichtblau said about price. I would simply add, Senator Warner, that I think I am most concerned about the linkage. There is a real linkage between oil prices and the financial plight of many countries. It is not, I think we would agree, the whole story, but it is such an important part of it that I am particularly concerned that without really wishing to make formal the link between oil prices and Venezuelan or Mexican situations, that through a rescue attempt we will in effect be supporting the price of oil. There is a link here, and I would rather if we didn't do it on an all together ad hoc basis, so I hope that your committee will be able to look into this.

I would say, Mr. Chairman, that while we have been talking about declining demand, and this has been translated into declining prices for the oil, that there is a minimum level of oil demand in the world. We cannot define it, but it exists. Governments are concerned about it. Companies are concerned, and whatever that level is, my personal guess is it is probably about 20 million barrels a day, in world trade, we are approaching it, and as we approach it, prices will firm. There may be continued small drops, but I do not anticipate any major collapse simply because this level, wherever it is, would generate its own pressures upon world oil.

In this regard, I think one of the interesting things about this particular hearing is the opportunity to give competitive analyses and for people to inject the sort of warnings about the assumptions that are very widely held. The critical role of Government in oil I have listed as one of the certainties of the world petroleum outlook. Paradoxically, it is the element which introduces a great doubt into all petroleum forecasts. It is extremely difficult to know what the key people of Europe, Japan, indeed the U.S. Government, may think and do about the world petroleum supply, the price being now the major consideration.

I am not at all confident that when OECD's economic recovery sets in, the pressures to obtain oil go up, that the producing governments will have learned a lesson that they might have about the events of the last decade. I would hope that that kind of a discussion about lessons would be an explicit part of discussions as to IMF rescues and so on. Otherwise we are quite likely to find ourselves back in an all too familiar situation by the end of the decade.

Thank you very much.

[The prepared statement of Dr. Conant follows:]

TESTIMONY OF MELVIN A. CONANT, PRESIDENT
CONANT AND ASSOCIATES, LTD.
WASHINGTON, D.C. 20036

SENATE COMMITTEE ON ENERGY AND NATURAL RESOURCES
February 21, 1983

Mr. Chairman, members of the Committee, I am Melvin A. Conant, formerly Assistant Administrator for International Energy, Federal Energy Administration (1974-76), a Senior Government Relations Counsellor, Exxon Corporation (1962-74), and previously with the Council on Foreign Relations, Inc. and on the faculty of the U.S. National War College. My firm concentrates on the geopolitics of energy, particularly oil and gas and publisher of a monthly report on the subject.

Since petroleum analysts, in common with general economists, did not foresee the sharpness of the decline in OECD economic performance, it is now customary to emphasize the general unpredictability of oil. It is not, however, its unpredictability which we should stress as much as our failure (1) to understand enough about our energy economics and (2) to relate to our world petroleum outlook several "permanent" features which shall give us continuing concern.

The elements of unpredictability -- caused mainly by the wholesale intervention of governments into supply -- have been with us since the mid-1960s.

We do not know enough about the following aspects of world energy generally and of oil in particular:

(1) We do not understand enough about the relationship between GNP growth rates and energy demand;

(2) We are not certain enough about the many facets of energy to be able to think about the range of considerations which lead a consumer to invest in an alternative to oil;

(3) Nor are we sure enough about our demand data. We cannot tell you how much of the reduction in energy demand is due to permanent improvements in energy efficiencies or to the economic slump. If we can't tell you that, we cannot reassure you that the days of 1972 will not return with substantial OECD recovery.

(4) Despite all of the technological advances in oil exploration, we cannot depend upon prospective regions -- outside the Middle East -- actually proving commercial. We are not sure enough today about energy demand and price to believe that even significant discoveries will be exploited for some years to come.

(5) We can only hope that the anticipated burgeoning demand for oil by LDCs will be met from yet-to-be-discovered domestic supply. We have no way of knowing without more extensive efforts.

(6) Moreover, I'm not sure that we could tell you how much is being invested into alternatives to oil, what has been postponed or cancelled, and by whom, in terms of specific projects located where and to what medium-term effects on world petroleum outlook. We have pieces of the puzzle and we guess at the aggregates.

Still, there are certain, important aspects of world petroleum which can be defined as "permanent" features of an outlook:

(1) With our continuing failure to discover and develop supergiant oil fields within the territories of the industrial states, most of the OECD world will continue to be dependent upon oil imports for the larger share of their petroleum needs.

(2) The Middle East, which remains the most prolific oil region of the world, will continue to supply the larger share of the oil barrel placed in international trade. For most of the industrial world, there is still no alternative to Middle East supply.

(3) Much is made today about the amount of oil produced by non-OPEC members. More should be said about the interest of all oil producers/exporters -- in and outside of OPEC -- in obtaining the highest possible price for the commodity;

(4) and much more should be thought about this observation: with OECD economic recovery, the volume of oil moving internationally will move upward. Most of the non-OPEC producers are still producing near to capacity; most OPEC suppliers are not. The spare producing capacity of the world lies very largely with the OPEC membership: perhaps as much as 20 MMB/D. It is they who will be looked to for additional supply; there is none other.

(5) Over the next decade, at least, there can be no reasonable doubt that there are sufficient physical reserves of oil to meet any plausible level of demand; without repeated discoveries of very large fields -- "supergiants" of over 5 billion barrels -- however, the role of oil as the leading commercial fuel of the industrial world will surely have declined and the race for energy alternatives will have begun in earnest. Outside the discoveries of the Middle East, these supergiant fields have been relatively few and far between.

(6) What is equally certain, however, is that commercial considerations will not again be the prime force in shaping supply -- the role of government guarantees that a broader set of objectives will be injected into decisions about production, price, volume, and destination than was the case until the early seventies when international oil flows were managed by the private oil giants.

(7) Until OECD economic health is greatly restored, we could accept as "given" the great difficulty oil exporters will have in organizing political actions to limit oil supply; there is no discernible cause for such actions which would involve more than a few and existing spare capacity is ample to replace contrived shortfalls. Moreover, the strategic petroleum reserves of the members of the International Energy Agency (IEA) are now sufficient to cope with a moderate, shortfall lost through a producers' combined political action.

(8) In terms of supply emergencies, the outlook for world petroleum is far more likely to be darkened through war damage to facilities in the Gulf, not through embargoes or boycotts. While we cannot tell when, by whom or where war will strike these facilities, the likelihood of such happening in the Middle East is so great as to warrant close attention to the importers ability to withstand a major, prolonged curtailment.

The foregoing are illustrative of the range of considerations certain to affect the world petroleum outlook. What more can be said with reasonable confidence about the next five years?

If we anticipate a prolonged economic slump, then a decline in the price of crude is certain. Were the decline to be close to what is now the real market -- a $4-$5 decrease per barrel -- we should not be surprised and, indeed, be pleased. If, for reasons of panic trading in "futures" or in the more traditional spot market, the price should plummet to the low range of $20-$23, so many additional interests would be affected as to make likely some form of price support tacitly agreed to, at least, by key importers as well as the producer/exporters.

This could be done indirectly through financial aid to key producers in trouble, the sustaining of the banking system and of energy investors, etc., each one of which implies support of oil prices. It need not be attempted through formal, direct agreements and the effort should not be made in such fashion lest we lock ourselves into a cartel-like association. But we should be clear that when the United States, with others, rescues a key producer such as Mexico, Nigeria, Venezuela, or Indonesia it is hard to believe that aid is given without consideration of a major cause of their difficulties: decline in revenues from the sale of oil.

Moreover, while it is true that price-cutting of one form or another is now endemic and is widely commented on, we ought to remember -- as indicated earlier -- that every oil exporter, in or out of OPEC, has the same fundamental objective: to keep its oil revenues and thus to support the highest possible oil price. We ought not to discount the possibility that OPEC will recover its unity if the financial plight of key producers deepens still further. OPEC's efforts to keep oil prices high will have the tacit support of not only all other producers, but of domestic energy investors, banks which have made energy loans and also those with interests in other forms of energy -- coal and increasingly gas -- for which the international price for oil is the benchmark for their own prices.

Mr. Chairman, there is a widespread assumption that oil prices will decline and some anticipate a drop. I am not so sure. Apart from the vagaries of the spot market and the additional speculative input of the burgeoning "futures" market, we ought to reconsider these points:

(1) For as long as the strength of the dollar appreciates against other leading currencies there may have been no reduction in the price of oil for most importers, other than the U.S. Moreover, for producers/exporters the increasing strength of the dollar has helped insulate them in some measure from the decline in their sales. If the U.S. dollar continues to be the currency for international oil trade, we have to be aware of its impact upon the purchasing power of other states.

(2) There is a minimum level of oil consumption in the world. What it is no one can say. But it exists. As the decline in oil consumption continues, we approach that minimum level; as a reduction in commercial (and maybe government) inventory levels continues, as it may be doing, we approach that minimum level more rapidly. If we can assume there will not be a further marked decline in OECD economic health, then I would guess we may be close to that minimum level. All of this is to suggest we need to argue -- through the kind of competitive analysis your Committee provides, different perspectives on the world petroleum outlook.

I have mentioned the critical role of government in oil as one of the certainties. Paradoxically, it is the element which introduces a great doubt into all petroleum forecasts. When commercial considerations were the principal force affecting demand and supply, a vast international system was created whose reliability, and reasonable price in all respects, were instrumental in ushering in the oil era and making oil the leading commercial fuel of the world. The fatal flaw in that system was the very large dependence of the companies on oil found within the one time colonial belt of the world. There were many warnings the system would not survive the winds of nationalism which became so strong after World War II. Governments of the oil-wealthy countries, by and large, had no private sector capable of assuming control over their oil trade and most of them saw no need for it; government would protect and foster the nation's patrimony.

By the early seventies, the transition away from the familiar system of private international oil companies was virtually over. The power of government seemed absolute; price surges, threatened political uses of the oil weapon and unilateral changes in contracts were the result; dependable supply on desirable terms was the casualty. These excesses led to greater interest in energy alternatives.

Now, because of the OECD economic slump, the producers learn of their vulnerability not only of their power. To their astonishment, the financial institutions of the OECD community hold what constitutes a new form of "oil" power, which is real and vital. And it will last until economic recovery sets in. We shall then see if the oil exporters learn from the experience of the past several years. If not, price surges and the other excesses will again be familiar, greatly modifying once again anyone's "world petroleum outlook," and bringing to a premature end the era of oil.

All of these matters remind us of the extent to which the issues arising out of petroleum demand and supply will continue to permeate our national and international concerns.

The Chairman. Thank you, Mr. Conant.
Mr. Schuler?

STATEMENT OF G. HENRY M. SCHULER, DIRECTOR, ENERGY PROGRAMS, CENTER FOR STRATEGIC AND INTERNATIONAL STUDIES

Mr. SCHULER. Thank you, Mr. Chairman. It is a privilege to be here today.

At the outset I would like to make a couple of things clear. First, I will be discussing the international oil pricing structure which is at the same time both broader and more narrow than OPEC, broader because formal membership in OPEC is not required to follow the OPEC pricing levels; more narrow because the real control over OPEC is lodged in the hands of Saudi Arabia which has enormous flexibility at both ends of its production capability.

Second, I would like to make it clear that the future is far from obvious. We still wouldn't be debating, a month after the so-called collapse of OPEC, what the future was going to be.

Third, I want to make clear that I would personally favor a price reduction of whatever magnitude the market would dictate if I were convinced that that price reduction would stick, but that is not my conviction. I think that we would find it fall and we would find it rise again very shortly thereafter.

And finally, I want to make clear that I can only provide one man's perspective on this, and that is a perspective that is based upon experience and upon political assessment rather than upon projections of supply and demand or indications in the press of what the spot market may be. Over the years I have certainly found that we usually have got the supply and demand projections wrong, and I have seen a good deal of manipulation of questions about what the spot price is.

I would also say, though, that while a politically based assessment of world oil pricing direction has proved valid for the 12 years that I have been trying to make forecasts, there is no guarantee that that is going to be any indication of the future of world oil prices at this point, but if in fact that turns out to be wrong and this political sort of assessment is inaccurate, then I would urge all of you to consider what the implications will be for political stability in the Middle East because it is those implications that will ultimately control world oil prices.

Having established those ground rules, let me start by saying that in my judgment, Sheik Yamani made a strategic and tactical error at Geneva in not accepting the agreement that had been worked out, and indeed an agreement had been worked out at an overall OPEC production level on the order of magnitude of 17 to 17½ million barrels a day, a level that there was definitely demand for OPEC oil of that magnitude there. Therefore, it would have supported the price of $34 a barrel.

In addition at Geneva the production quotas for all of the OPEC members had been worked out. Because the Saudis had indicated a willingness to reduce their share from the absurdly high 40 percent that they had been assigned in March 1982, a level that the rest could not live with, the Saudis agreed in Geneva to reduce that to

25 percent, and when they did so, all of the rest of the producers fell into line and accepted quotas.

There also was agreement that the discounts would be eliminated at Geneva. The only thing there was not agreement on was the level of the differentials as between different qualities and different locations of crude oil, and I submit that those differentials are trivial or certainly technical at most. They are the sort of things that the international oil pricing structure should not be jeopardized because of.

Now as a result of that error that was in my judgment committed at Geneva, Saudi Arabia faces an economic and political dilemma—whether to reduce price in order to maintain their market share, or whether to reduce production in order to maintain the official price of $34.00 a barrel.

Looking first at the economic considerations, I submit that they can have little confidence in the economic or revenue advantages to be gained by cutting price. They can have no confidence in the timing or magnitude of a long-term demand increase. If you consider the fact that with the benefit of 4 years of hindsight we do not know what the impact of a real structural impact of $20 a barrel increase was in 1978, I submit that no one could have much confidence in what a one-third of that price reduction, pulled into one-third of that, what kind of impact that would have on long-term demand, but the long term is a long time away. It is the short term that is of concern to most of the OPEC producers, and we have already seen that there has been a reduction in demand for OPEC oil to the level perhaps of 15 million barrels a day. It is simply market psychology taking over. It is the anticipation that the price of oil is about to collapse, and that, therefore, buyers say I will run down my inventories before I start buying oil because I will wait until the bottom of the market is reached.

I contend that if the Saudis reduce the official price of oil and it is in fact the first reduction in the official price of oil in 23 years, in the 23 years that OPEC was founded in 1960, and that will be a further signal to buyers to hold off and buy when the price is falling even more, looking at it from a revenue point of view, I heard on the way over in the car this morning, Dan Lundberg says the Saudis will reduce their price by $7 a barrel. They are currently producing 4 million barrels a day, so through that price reduction of $7 a barrel, they lose $28 million a day in revenue, and at the new price of oil, $27 a barrel, they would have to increase their exports by 1 million barrels a day, but where is that million barrels a day going to go? We have just indicated that there is no short-term demand and that the future of the long-term demand is at best uncertain.

Therefore, any increase has to come out of the exports of the other OPEC producers or non-OPEC producers, and they need revenues far more desperately—Iran to prosecute a war, Nigeria to keep the lid on a very explosive situation, Mexico to pay its debts, Venezuela to prop up its economy—so I contend that these countries will be very sorely tempted to match any sort of a reduction in the Saudi price and produce the start of a ratchet of prices downward which will be the counterpart of the ratchet of prices upward that took place in the early 1970's, but beyond these entirely uncertain economic advantages of a price cut, there are far more predictable political risks inherent in such a cut.

Without wishing to imply that political instability is either inevitable or imminent in Saudi Arabia, the House of Saud has been given very real cause for concern about that political stability. The attack on the Great Mosque just a couple of years ago revealed that religious fundamentalists and tribal traditionalists, the two sources of legitimacy of the House of Saud, and other internal security support, are concerned about the pace of change within the Kingdom, a pace that is fueled by high production and the presence of many foreigners, the Shia oil workers who are disadvantages in the Eastern Province and vulnerable to the pressures that are there and the propaganda from Iran, reformers who criticize the decadence and corruption of certain elements of the royal family, concerns that have recently led King Fahd to impose passport restrictions on some of his half brothers, technocrats who criticize the uneconomic development projects, $100 billion spent on Jubalin Jambu to produce steel mills and petrochemical plants and export refineries that were never very sound investments but are certainly less so in this situation; the young military people in the Saudi forces who are concerned about the strings that are attached to these massive purchases of American arms, the Pan-Arabists and Saudi nationalists who contend that the Kingdom is entirely too much influenced by ARAMCO and by the United States, the Palestinians who have long threatened sabotage and threats are more real today in the aftermath of the camp massacres in Beirut and Iran, of course, which only a few minutes' flying time across the Gulf is preaching subversion and threatening to bomb Saudi facilities.

In every instance a decision to increase market share by reducing price and thereby threatening the collapse of the entire system will be viewed by those elements who are already hostile as being unnecessary, or to look at it from the point of view, rightly or wrongly, of those people who are unhappy. We have a situation in Saudi Arabia where 2 percent of OPEC's population is enjoying 25 percent of OPEC's revenues. Now it is pretty hard to contend that they need to have more than 25 percent.

Put another way, in 1982 even in the rather tightened circumstances, quote, unquote, every man, woman, and Saudi child enjoyed $18,000 in per capita oil income and investment income. The comparable figure in Iran is $400. In Nigeria it is $200, and I haven't done it for Indonesia but with all the people who live out there it must be even less.

Put another way, the Saudis now have at 1982 oil revenue levels, they have 3 years stowed away in the bank. The Iranians have less than 1 month's oil revenues in the bank, and the Nigerians are $10 billion in debt.

Now I am not talking about equity. I am talking about just hard-nosed politics in this situation. For the Saudis to contend that they have to expand market share in order to maintain that disproportionate amount of revenues is not the kind of astute and cautious leadership which the House of Saud has shown over the years and which has allowed the House of Saud to survive all these years.

Therefore, I believe that they will show this kind of astute and cautious leadership and avoid a cut of any sort in the price of oil and I recognize that I fly in the face of all the other forecasters at this point, but I just think that from a political perspective, it would be unwise for the Saudis to do so, and if they do not choose the course of wisdom, then I think we all had better beware of what is going to happen to stability in the region. I think that they could still put together that agreement that had been reached in Geneva and that was jeopardized over trivial matters.

I think it would take, to turn the psychology of the marketplace around, it would take a rather clear-cut signal, but I think that certainly that could be achieved, and the Saudis could turn the situation around and support the $34 price.

If my confidence in their wisdom is misplaced and in fact the price of world oil collapses, then I think we will be certain to see emerge from the ashes a cartel that will be far broader and far stronger than the cartel that is in place now. I think the situation is directly comparable to that which existed in 1960 when the Seven Sisters who administered the international price of oil were faced with an oil glut, faced with Iran's seeking to flood the market with oil in order to gain revenues that had been lost during the years it was shut down by the revolution, a comparable situation to today, when Exxon refused the price of the Saudi market crude in August 1960, 1 month later in September, OPEC was formed, because the interests of the producing states were too strong to allow a collapse of prices.

I see no reason why we would not see arising out of the ashes of OPEC a new cartel which would include the price cutters, Mexico and the North Sea, because it is obviously, as Mr. Conant indicated, in their interest to maximize their revenues, regardless of the fact whether they speak English or Spanish or whatever.

These two scenarios that I have postulated, that the price will not be reduced or that a cartel will arise out of the ashes, may in fact turn out to be the good scenarios. For the bad scenario, it could be if the political pressures produce sabotage, attack by Iran on Saudi facilities, or internal upheaval. In that case, we would be faced with a regime which would seek confrontation with oil consumers.

In all three scenarios, therefore, the oil consumers remain vulnerable to supply interruptions and to price escalations, and in that connection I came across and brought with me a newspaper clipping from the Financial Times which reads, "The Middle East Crisis—Why Threats to Oil No Longer Cause Alarm," and I think you have all seen these headlines in recent newspapers, but this one is dated May 23, 1967, and within 3 weeks of this the Arab embargo that in fact was anticipated, that is what prompted this newspaper article, had come to pass, but all the producers who were the new supply that had been developed outside the Middle East turned out to be simply a shadow because in fact Libya, despite the fact that it was on the African continent, joined the embargo and Nigeria through totally unrelated circumstances, the Nigerian Civil War resulted in a federal blockade of the Biafrian oil terminals. As a result, within 3 weeks of this great optimism Britain was in fact faced with petro rationing and the price had escalated by 20 percent, so in light of that, I can only urge that we must continue to go ahead with development of the domestic U.S. resources that we are so blessedly endowed with.

Thank you.

[The prepared statement of Mr. Schuler follows:]

Testimony Submitted to
Senate Enegy Committee

Hearings on
"World Energy Outlook"
February 21, 1983

by

G. Henry M. Schuler
Director, Energy Programs
The Center for Strategic and International Studies
1800 K Street, NW Suite 402
Washington, DC 20006

(202) 775-3256

February 17, 1983

At a time when the press has been full of speculation about a dramatic collapse of world oil prices, I welcome the opportunity to present testimony about the free world's persistent oil vulnerability. As holder of the Dewey F. Bartlett Chair in Energy and National Security at CSIS, a policy research center which focuses upon strategic and international issues, I am deeply concerned that the so-called "oil glut" has obscured the continuing threat posed to the free world's military preparedness, alliance relationships, diplomatic flexibility and financial stability.

The level of free world imports has, to be sure, been reduced, but American reliance and European and Japanese dependence remain gigantic by any measure. Thus, in 1983, the United States still imported almost one-third of its total oil requirements at a cost of about $60 billion while our allies imported close to 90 percent of their combined oil requirements at a cost of over $150 billion. Moreover, while there has been some shift in the source of that oil, we must not lose sight of the fact that the Middle East still accounts for about half the oil moving in world trade; that adding the exports of other Arab states (Libya, Algeria, Egypt and Tunisia) raises that level to two-thirds; and broadening it to include other countries where Moslems predominate (Nigeria, Indonesia and Brunei) raises to 80 percent the share of world oil trade responsive to Islamic interests and concerns.

While these countries have made enormous economic strides in recent years, political institutions cannot be developed at such a hectic pace. In fact, few if any enjoy the political stability which comes from institutionalized legitmacy and the consent of the governed. Therefore, they must use the only instrument at their disposal -- oil policy -- as a substitute for political stability, diplomatic maneuvering room and military might. History had demonstrated that successful utilization of the oil instrument has usually come at the expense of higher oil prices, but experience has also shown that unsuccessful utilization is even more painful as political upheaval interrupts supplies. In short, consumers have tended to suffer from the fragility of the oil exporters, whether or not that fragility actually leads to political change.

In light of the free world's continuing reliance upon inherently fragile exporters, it seems to me that we should ask a number of questions about the currently fashionable expectation that Saudi Arabia will reduce the official price of the "marker crude" by $2-4 per barrel.

- How would such a reduction impact upon the world oil pricing structure?
- How would it impact upon the stability of Saudi Arabia?
- How would it impact upon the overall strategic and security interests of the United States?

The World Oil Pricing Structure

No one -- not least the Saudis -- can forecast with any confidence the impact on the international oil pricing structure of a $2-4 per barrel reduction in the price of the marker crude. It could not be otherwise, for there has never been a reduction in the official price of world oil since OPEC was founded 22 years ago to avoid just such reductions as are now being contemplated. The only possible reason for embarking on such uncharted ground would be an expectation that world oil producers -- OPEC and non-OPEC alike -- would rally to support a $30 price when they would not support a $34 price. There is little analysis to support such an expectation.

o It is difficult to see how such a reduction would significantly increase world demand for oil. After all, with the benefit of 4 years of hindsight, Western economists cannot agree on the degree to which world demand has been structurally affected by a $20 oil price increase in 1978/79, so the Saudis cannot have much confidence in their ability to forecast the impact of a change only 10 to 20 percent as large. But even if we grant that a price cut is directionally correct in producing some demand increase over the medium to long term, most observers of market psychology believe that any cut in the official price of the marker crude will trigger an immediate reduction in demand as buyers seek to use up their high priced inventory and wait for the market to "bottom out." This pheonomenon is already underway on the basis of persistent rumors of a Saudi price cut so fulfillment of those rumors is likely to bring buying to a standstill, for there will immediately be new rumors that Iran or some other exporter is planning to match the cut in order to maintain desperately needed revenues.

- It is equally difficult to see how a $2-4 reduction would enhance Saudi revenues. In fact, with Saudi exports running at about 4 million BPD, a $4 price cut would reduce daily revenues by $16 million. To make this up through volume, the Saudis would have to export an additional half million barrels per day. But where is that market to be found in a period of falling demand? It can only come out of some other exporter's share, but we are told that several of them are so desperate for revenues -- Iran to prosecute a war, Mexico to pay its debts, Venezuela to prop up its currency and Nigeria to keep the lid on an explosive situation -- that they would be forced to match a Saudi cut in order to maintain exports.

It now seems clear that Shaikh Yamani made a serious strategic and tactical error in refusing to accept the putative agreement worked out a month ago in Geneva. The difficult questions of overall production ceiling and market shares had been worked out to everyone's satisfaction at a level of 17.5 million BPD which most analysts believed would support the $34 price. It was unwise to permit that agreement to collapse over differentials which are trivial, or at best technical elements best left to the OPEC technicians in Vienna.

There is little to be gained in speculating about the reason for Yamani's unwise rejection, but it has left the Saudis with a more difficult dilemma than they faced prior to the meeting. By triggering talk of a price collapse, Shaikh Yamani has created a market psychology which threatens to become a self-fulfilling prophecy. Regrettably, the Saudis find themselves in a situation which demands dramatic action to reverse that psychology but one in which their options are limited:

Firstly, they could announce an immediate $2 to $4 price cut alone or in league with the Gulf Cooperation Council. But that creates the economic risks inherent in a ratcheting downward or free fall of oil prices and the political risks which we will discuss in the next section.

Secondly, they could threaten to implement such a price cut at a future date unless OPEC comes to agreement. In a sense, Shaikh Yamani has been pursuing this strategy through rumors and press conferences. There have been reports that the implied threat coupled with a promise of Saudi financial aid has brought the Nigerians into line, but that could be an extremely costly route because other Saudi allies -- including Egypt -- will expect similar protection against unpredictable market conditions. Moreover, this tactic has not brought the Iranians around as an informal threat, and it is unlikely to be more effective as a formal threat unless it is also accompanied by a generous "carrot." While the Saudis have never been loathe to pay Danegeld, it is hard to foresee such cooperation at a time the Kheomeni regime remains committed to the overthrow of the House of Saud as well as Saddam Hussein. In any even, such a threat would not be seen as having much impact on non-OPEC exporters even if Iran and the other OPEC members fell into line.

Finally, the astute and cautious princes of the House of Saud, could decide that a mistake had been made at Geneva and attempt to resurrect the essential elements of that agreement. The reasons which produced agreement on the important questions a month ago are even more clear now that OPEC has glimpsed the alternatives. Therefore, what is required is something which will send an unmistakable signal to the market place as well as "save face" for all concerned. Such measures are not beyond the realm of possibility, for, whether or not it is deserved, it is clear that most of the animus toward Saudi tactics is focused upon Shaikh Yamani who is also the Saudi most closely identified with the view that oil prices are too high. If the King were to decide to retire his Minister of Petroleum after some 15 years of loyal and astute service, it is likely that the other countries would rally around the erstwhile Geneva Agreement.

The Stability of Saudi Arabia

In choosing between their various options, the senior Saudi princes will give the highest priority to preservation of their own stability. Without wishing to imply that instability is imminent or inevitable, we must not shy away from the fact that the House of Saud itself recognizes that it faces a variety of challenges.

- The assassination of King Feisal in 1975 and the attack on the Great Mosque in 1979 have reminded the princes that the rapid pace of change and the extensive presence of foreigners disturb the tribal traditionalists and religious fundamentalists who provide the internal security forces and the basis of legitimacy for the House of Saud.

- Trouble among the Shia oil workers of the Eastern Province in 1979 forced the rulers to recognize that a strategically placed minority of their own Arab population enjoyed only second class citizenship which made them vulnerable to Iranian appeals for greater Shia assertiveness.
- Reports of decadence or high living abroad by family members have reached such a level among reform-minded Saudis that King Fahd has imposed passport restrictions on some of his extended family.
- The educated elite and technocrats have long questioned development policies which required excessive oil production rates in order to fund uneconomic industrial projects.
- Pan-Arabists and Saudi nationalists have criticized past price restraint as being overly responsive to the economic interests of the United States and the commercial interests of ARAMCO.
- Elements of the armed forces are almost certainly chagrined by the strident criticisms and restrictions which accompany the American arms on which the Kingdom is spending billions.
- The long-standing threats of the more radical Palestinians to sabotage Saudi oil facilities in retaliation for the House of Saud's close

identification with the United States take on new urgency in the aftermath of the Beirut massacre conducted by the forces of Bashir Gemayel who was invited to Riyadh just before his death.

- An unstable Iranian regime which broadcasts incessant appeals for the overthrow of the House of Saud, uses its pilgrims to spread subversion and periodically threatens to bomb Saudi oil facilities is increasingly frustrated by the Iraqi defense which is funded by Saudi Arabia.
- The long-standing subversive menace posed by the Qaddafi regime in Libya has only just been defused by the resumption of Saudi-Libyan diplomatic relations last month.

While reiterating that no one can predict if, when or how these challenges will affect the future of Saudi stability, they are nonetheless challenges which receive ample attention from the ruling family. Therefore, the senior princes have to ask themselves how a price reduction and possible price collapse would impact upon those challenges.

In answering that question, they cannot escape the fundamental truth that they would be reducing price in order to maintain or enhance market share. While such a position is technologically easy and commercially justified, it is far less clear that it would be politically wise to take a step which is designed to grab market from more needy competitors and which might lead to the collapse of the world pricing structure and the many exporting governments dependent upon it. Forget the equities but consider the politics of a stance which says that Saudi Arabia with just 2 percent of total OPEC population requires more than the 25 percent of total OPEC revenues which was granted to it in the tentative Geneva agreement. How do you convince Iranians or Nigerians whose 1982 per capita oil and investment income amounted to $400 and $200 respectively that the comparable Saudi citizen share of $18,000 was not enough (let alone that of Kuwait and the Emirates which was over $30,000 for every citizen)? If you were the Iranian government with less than one month's oil income in the bank or the Nigerian with $10 billion in debts, would you expect the Saudis to dig deeper into their three years of accumulated oil income before insisting upon preserving market share?

The Saudi princes who must ask these questions may not like the answers, but they cannot ignore them, for they know that all of their critics will accuse them of avarice if they reduce price to enhance market share. It requires little prescience to anticipate the ways in which a quest for higher production levels will be woven into the arguments of all those previously enumerated challengers within the country and the region. While no one can say whether that policy choice would trigger serious instability, the Saudis could reasonably conclude that it presents political risks which ought to be avoided unless the economic benefits are sufficiently clear. But we have already seen that the economic justification for a price cut is far from clear.

American Strategic Interests

In assessing the impact of the current Saudi dilemma upon overall American interests, we must start from the recognition that we cannot be sure of how events will develop. At this point, (February 17), I am inclined to believe that the certain political risks and the uncertain economic benefits will prompt cautious and astute Saudi leaders to avoid a reduction in the official price of oil and to seek revival of the Geneva agreement. If they can signal that they and the other exporters intend to make this stick, then I expect that the growing economic recovery and the need to replinish drastically depleting stocks will preserve the existing international oil pricing structure intact. Consumers who are dependent upon international oil supplies will enjoy only marginal and transitory benefits, but American consumers may benefit significantly from soft domestic oil prices.

If my confidence in the caution and astuteness of Saudi leaders is misplaced and they unilaterally impose the first reduction in the official price of oil since the founding of OPEC, then I suspect that the downward trend in oil prices will escape their control. In this event, consumers will enjoy greater savings but for an even shorter period. The last time there was a reduction in the official price of oil was in August 1960 when Exxon reduced the posted price of its Middle Eastern production in respose to the growing oil glut and soft market. Then, as now, secret discounts were prevalent because Iran was trying to catch-up on revenues lost during the Mosadeq period and exporters who did not subscribe to the international oil pricing structure administered by the so-called "Seven Sisters" were increasing production. Within one month of the companies' failure to maintain oil prices, their task was taken up by the newly-formed Organization of Petroleum Exporting Countries. The stakes in stable oil prices are certainly no less today than they were in 1960, so a failure by OPEC would almost certainly lead to a new and expanded cartel including exporters which never subscribed to OPEC. The new organization would almost certainly restore prices to current levels.

But those are the good scenarios for consumers. There is also the possibility that a Saudi price reduction which triggers a broader collapse will prompt military attack, sabotage or internal upheaval. In that event, the currently complacent oil market will give way to panic as buyers rush to fill those depleted inventories. This could lead to price escalations just as the panic of 1978/79 did even though there was no fundamental supply short-fall.

In summary then, it seems clear to me that the current international oil uncertainties promise little relief from our persistent vulnerability to price escalations and supply disruptions. On December 8, 1982 CSIS sponsored a conference on this subject. We were privileged to present a program of prominent analysts who represented a wide range of disciplines, backgrounds, and political outlooks. Instead of attempting to present their views, I am attaching as an appendix to this testimony a set of executive summaries of their papers. If anyone wishes the full text of those papers, CSIS would be happy to make them available.

In closing, I would add only that American reliance and allied dependence upon oil imports presents every bit as great a threat today as it did before the so called "oil glut". Therefore, instead of reregulating natural gas, discouraging nuclear power and ignoring coal's potential, we must resume the development of domestic alternatives to imported oil.

The **Chairman**. Thank you. Your entire statement will be made a part of the record in full, and I would draw attention to the executive summary of your conference in December which you attached to your statement which will be made a part of our files, but I would invite the attention of those who were interested in the testimony today to the fact that that appendix does exist. It is in the file. You can get copies from CSIS if you desire.

Senator Johnston?

Senator **Johnston**. Thank you, Mr. Chairman. Mr. Chairman, I would join with you in praising this panel. They are finest available experts in the world, I think, on this subject, and as usual, we weren't disappointed.

Gentlemen, as I get your collective testimony, all of you think a collapse of OPEC, a collapse of world oil prices, that is something below say $28 a barrel, is unlikely. Is that correct?

Dr. **Lichtblau**. Well, I would say it is unlikely but not nearly as unlikely as it seemed to be quite recently. We are moving away from the unlikeliness. I think the events over the weekend have changed some basic facts. One of the major OPEC countries has just broken the line, has gone down on its own in a very substantial amount, $5.50 a barrel.

A couple of weeks earlier Ecuador, which is a very small OPEC member, had declared it would not sell oil on the open market, whatever the market price was. This was generally ignored, but it was another OPEC member, the first one deciding to break with OPEC for the time being. Now you have two of them, and Nigeria has also declared that if Saudi Arabia would set a price lower than the $30 level that it has done, Nigeria has done, Nigeria would go down again.

On the other hand, if Saudi Arabia does not set a lower price, then Saudi Arabian oil would be very difficult to sell. Saudi Arabian's complaint was that Nigerian oil was only $1.50 more expensive which was not enough. If they are both at $30, then there is a zero differential. If a $1.50 differential was acceptable to Saudi Arabia, would a zero differential now be acceptable? I don't know, but you have I would say OPEC on the brink. It hasn't gone over the brink, but the situation could get out of hand and what seemed not likely at all is still perhaps less than a 50-50 chance, but not much less today any more.

Mr. **Schuler**. Senator Johnston. I would say that yes, there is a very real possibility of a short-term collapse, but my emphasis is on the short term because in the long run there will not be that sort of collapse.

Senator **Johnston**. Is it likely that there will be a short-term collapse?

Mr. **Schuler**. I consider that if Saudi Arabia reduces the price of its oil by $2 and $4 or $7 to match the Nigerian cut, then I think the collapse of world oil prices is very real because the market psychology, buyers will just refrain from buying and the others who need the revenues desperately will match the Saudi cuts.

Senator **Johnston**. How long can ARAMCO partners afford to pay the higher Saudi prices?

Mr. **Schuler**. I can't speak for ARAMCO certainly, but as they well know, they enjoyed what was called the ARAMCO advantage for a good many years where they were buying Saudi oil at less than the market price and that it is my understanding that that sum has been more than compensated by the ARAMCO disadvantage of recent years, but those major companies and particularly with Saudi Arabia holding 30 percent of the free world oil reserves and 30 percent of the installed production capacity, nobody walks away from that lightly, so I think that there are great pressures on them to continue to absorb those losses for a period.

Senator JOHNSTON. Dr. Conant?

Dr. CONANT. I agree with your formulation of the statement. I think it is unlikely. I would hedge to the extent that if there were a collapse it would bring about even more quickly the kind of joining of interest that Henry Schuler has referred to that could in fact accelerate the coming together of enough of the key producers of OPEC to make the difference.

I think we should also keep in mind that as was said, Ecuador is an insignificant factor in the world oil trade. Nobody really cares what Ecuador's supply is going to be. Nigerian supply is not all that important either. In the total picture we do have some sense of the extreme emergency of the financial situation in Nigeria and if I were on the Saudi side of this argument I think I would be continuing to plead with producers that there is that minimum level of oil demand. Don't panic. Don't break the system because you have a short term as they put it financial emergency, so I think there is recuperative power within OPEC.

Now, specifically, it might come through an understanding between the gulf producers to pursue an action in common. As far as the OPEC supply on the whole goes, of course, that would be far and away the most important part and would in itself have considerable stability.

Senator JOHNSTON. When President Reagan was running he was talking about the hemispheric oil policy. Jimmy Carter had spoken of that previously and it seemed to make no sense at all to me at that time, knowing the politics of Mexico and Canada. Now it seems to make a great deal of sense, that is, to enter into some long-term arrangement with Mexico and/or Canada, but we hear no talk of that.

Would you agree that that is a policy option we ought to pursue vigorously at this point?

Dr. LICHTBLAU. Well, it might be, but what can we offer Mexico? Buy their oil at above market prices? At market prices they can sell it, and the same thing applies to Canada, although Canada less so because Canada is not a major exporter. We do now buy about half a million barrels a day of crude oil and I think that comes over the pipeline that is more or less fixed, but as far as Mexico is concerned, I don't know what we can offer them.

The same thing applies to Venezuela. Would we want to pay a higher price for Mexico oil in order to prop up their security? Maybe we would.

Senator JOHNSTON. ARAMCO, that is to say, us, the United States, is paying more to OPEC.

Dr. LICHTBLAU. But Iraq is losing money. Iraq is not passing that price on in its gasoline cost or its heating oil cost. ARAMCO is losing money on every barrel of Saudi crude oil. The ARAMCO consumer pays for its gas with gasoline and heating oil on the basis of a $29, $30 price, not $34, but if we bought oil from Mexico at a higher price and from other what we call secure sources, then we would have secured sources in the higher cost of oil.

Senator JOHNSTON. Dr. Conant, you wrote a study for this committee a couple of years ago on this subject. Considering our perceived obligation or desire should I say to keep Mexico from collapsing and therefore having a revolution, would you not concur that it would pay us to have a long-term relationship? Is it politically possible? Is it economically possible?

Dr. CONANT. I still believe that, Senator, we among the key importers of the OECD world and the NATO Alliance have this option. While it is true that the Canadian/Mexican reactions have varied over time, I am inclined to think that at this particular moment they might be more interested in this. I think the failure of the President to elaborate upon his interest in this, I regretted that very much because I thought this was something which was going to be pursued.

I think my only comment about the process is that if it is oil itself, it will be too fragile. The Mexicans have interest in the U.S. economy which goes beyond oil itself. I would never exclude Venezuela from this concept of hemispheric, and therefore I think it has to be oil in the context of a much larger economic understanding than has been discussed in past years.

Senator JOHNSTON. The time is now to pursue this, isn't it? It is too late, but we ought to do it now with a real vengence, wouldn't you say?

Dr. CONANT. I would just make one comment about the brief reference to the testimony of the Energy Secretary on this matter where he appeared to be discounting the importance of the Persian gulf to the United States as a consequence of changes in the source of supply. I think this is all too tempting, but that it doesn't reflect the true range of U.S. strategic interests in the region. We could become totally independent of gulf supply and still find ourselves as a result of a NATO link deeply involved in the terms of continuity of supply to Europe but also, of course, to Japan, so when we make these moves or think about them, they have to be awfully sure that all of the parameters are included, and then I think we could move.

Senator JOHNSTON. Some of you seem to be suggesting when you speak about financial aid to key producers, Dr. Conant and someone else said something suggesting an import fee.

Dr. Lichtblau, could you give me your judgment on an import fee? Mr. Schuler, first of all?

Mr. SCHULER. Senator Johnston, as somebody who is concerned about the national security implications of energy, I could certainly come up with a rationale that would support an import fee because it would create a national security premium for domestic alternatives, whether they be oil or coal or natural gas or whatever, because of the higher import cost would create a premium.

While I could justify that on the basis of a theoretical calculation, unfortunately my experience in negotiating with OPEC in the early 1970's leads me to the opposite conclusion, and that is because the argument that we constantly encountered and particularly from the Shah was that why should the producer states be getting, as was the case in 1970, $2 a barrel for their oil when the consumer in Europe was ultimately willing to pay $15 or $16 at the pump because of the taxes that the consuming government puts on? And unfortunately, that was an argument that none of us could ever really counter because in fact the consumer in governments were making money on oil that was a wasting asset of the producing states and we could never counter it and it helped to destroy the will and the ability to resist those demands, and I would fear that if OPEC is in disarray at this point, the one thing that could galvanize them into solidarity would be the consumer saying now we have got them down. Let's kick him and get a little bit of money out of this deal. It would bring them together as quick as possible, and that is why I would oppose it even though theoretically it makes sense.

Senator Johnston. Dr. Lichtblau?

Dr. Lichtblau. I would just like to say I am by no means advocating an oil import fee. I just raise the question in my paper, and my point was if the price of oil should drop substantially, not just $2, $3 dollars, but substantially, below $25, we may consider it.

I am also aware of the negative aspects of it because I don't think other industrial countries would—if our energy costs were higher than energy costs of other countries, we would have problems in our international trade, and there is one major consideration, but I am just saying we are the only major industrial country who is a very substantial producer of oil and gas at the same time. Therefore, the question of how do we protect the domestic industry whose price is determined abroad when that price falls, the obvious one is an import duty or an import fee, that sort of thing, which is the standard procedure. We may consider it, but it has some substantially negative effects and we should weigh these first.

I am not advocating them. I was just raising the issue. I was hoping Senator Domenici would be here.

Senator Johnston. Dr. Conant?

Dr. Conant. I try to separate in my mind what is an urgent requirement on the part of our Government for additional revenue from the energy repercussions of an import fee. I think I could be persuaded that the revenue requirements of the Government are a justification to an oil import fee, but if that is the case—I guess it is—can't we move toward one of our energy objectives by making this an additional tax upon the consumption of energy, especially of gasoline? I would rather see us raising the revenue and doing it in ways which might encourage energy discipline, even investment into alternatives than to have it simply an import fee without further regard.

Senator Johnston. I don't want to monopolize the time. I would like to ask you one quick question in which I would appreciate it if you would answer it yes or no. Starting with Dr. Lichtblau, should we continue with our synthetic fuels strategy in this country?

Dr. Lichtblau. Yes.

Mr. Schuler. Yes.

Dr. Conant. Yes.

Senator Johnston. That's good. Thank you very much.

The Chairman. That's a well-trained panel.

Senator Warner?

Senator **Warner**. Thank you. Dr. Conant, I return to my great concern about the linkage between the world supply of oil and the pricing structure and the financial crises, and I judged from your comments here that you agree with me that there is a definite linkage in that area.

What concerns me is the possibility at the gas pump of the consumer in America on the one hand seeking lower prices and a certain group of banks in the United States endeavoring to keep that price structure up, and I read from your testimony, page 4, that OPEC's efforts to keep oil prices high will have support from, quote, banks and others, which are helping the energy loan situation.

What form might the banks' support take?

Dr. **Conant**. I guess I am afraid it is going to take the form of simple rescue.

Senator **Warner**. Of what?

Dr. **Conant**. Of simple rescue, and that there will be little time or opportunity to couple the rescue operation with what I would call greater fiscal discipline among the banks, among the producers who borrowed, greater pursuit of say the IMF structures, that none of this will help in the longer run unless things are done differently.

Senator **Warner**. Let's talk about that rescue because there is support building here in the Congress to add credit lines to the IMF which indirectly help the banks which have made the energy loans.

Am I oversimplifying by saying a vote in favor of added credit to IMF indirectly helps to keep up the world oil prices?

Dr. **Conant**. Yes, I think it will.

Senator **Warner**. Would other members of the panel care to comment on that?

Dr. **Conant**. One quick addition to this—so far as I know, the United States is the only major producer and importer of oil in which there is a public debate on this matter. In other parts of the world it is held within closed rooms, and I think this is a very vital example of how we do things differently and the kind of inquiry that is being made is essential.

Senator **Warner**. Same question to the other members of the panel—support in the Congress, a vote in favor of enlarging the IMF credit, is that indirectly supporting shoring up the world oil prices?

Mr. **Schuler**. Senator Warner, I am not entirely sure. I am not a financial man, but I would point out that there are for every country that is in difficulty that is an oil producer and wants higher prices, i.e., Mexico, there is a significant oil importer who is in every bit as dire straits and would like lower prices, i.e., Brazil, so I think it is, at least the financial analysts tend to think that there is something of a wash there, and I am not sure it is very clear how it comes out.

Dr. **Lichtblau**. We can't shore up the oil prices. I don't think the U.S. Government is in a position to do that, but we can increase our contribution in a vote for higher contributions to the International Monetary Fund, and I think if the oil price should collapse which we say it is possible but not highly probable, then I think it will be very important to have that kind of a backing because countries like Mexico and Venezuela, Nigeria, Indonesia, I think if the price should go down in the $20 range would probably not be able to repay their debts, and therefore it would be very important to have some backing for them so that they could continue to function economically internationally in that situation.

I think it is not necessary now, but we should have it because of the possibility we all agree here that a price collapse is real, even though it is less than 50 percent, and I think that action by the U.S. Government would be a backstop if it does happen. Otherwise with the collapse of the price we have the collapse of the economies of four, five fairly important oil exporting countries.

Senator **Warner**. Well, the question of the extension of additional credits in the IMF would be considered in the Congress I am hoping, Mr. Chairman, in the context of the next 60 to 90 days, and the formula for the amount of money to be contributed by the United States and other participants in that program is directly tied I presume to the world oil price.

Can we have assurances in the next 60 to 90 days about the world oil price to devise a formula and how much the United States should contribute?

Dr. **Lichtblau**. Well, I don't know whether we can tie it to the price of one single commodity. We are talking about a general contribution to the International Monetary Fund, and I don't know whether we want to do it. I don't know enough about it, but I do understand that there is a direct relationship between our need to do this and the price of oil and if the price of oil should collapse, we will have no choice but to do it and maybe we should prepare for this in advance.

Senator **Warner**. Well then, adding credit to the IMF will work toward keeping a collapse from occurring?

Dr. **Lichtblau**. Not a collapse of the price; the price will be, the price is determined either by the OPEC cartel or failing that, by the free market. If the OPEC cartel falls apart, then the free market could drive the price down to whatever it is independently of anything else, but if the price goes down, then these countries, these four, five countries, are in major difficulties, may not be able to repay the loans, will need assistance, and if IMF is in a position to give this additional assistance, the economy of these countries would then be saved, would then continue to function.

Senator **Warner**. Just for clarification, Dr. Conant's statement that OPEC's effort to keep oil prices high will have the tacit support of, quote, banks which have made energy loans, do you agree with that?

Dr. **Lichtblau**. Absolutely.

Mr. **Schuler**. Yes.

Senator **Warner**. That clarifies it. Thank you.

The **Chairman**. Senator Melcher?

Senator **Melcher**. Is it fair to say that this panel is in hopes that OPEC will remain a viable and a dominating cartel?

Mr. **Schuler**. I think, speaking only for myself in this, I hope that the international oil pricing structure collapses and stays collapsed, but that is only a hope. That is not realistic, so as an alternative I would rather see continued expectation on the part of the consuming world that prices are going to remain high because I think that will spur the development of alternatives and domestic supplies that we need to do.

Senator **Melcher**. Dr. Conant?

Dr. **Conant**. Senator Melcher, that is a very interesting question, a very difficult one to answer. I am not persuaded that OPEC in the past has acted in what I would regard as a responsible manner. I had indicated I am not sure that they will have learned a lesson and may regard what is happening today as an aberration.

I think if I were to look for an international group that would have oversight on oil I would prefer to see something which is a melding of the producers and the importers and consumers. I don't know how this could be done, but I am not sure I would be very comfortable with the simple preservation of OPEC.

Dr. **Lichtblau**. In principle, there is always a question, Is a cartel price desirable vis-a-vis a free market price, and basically, economics says no. OPEC is a cartel. It is functioning as one extremely successfully throughout the 1970's, and now much less so, so the question is really do we want a cartel to determine the price of oil indefinitely, and the answer isn't that obvious. In principle, no, but at the same time if the price of oil should fall all the way to the temporary market clearing level, a lot of the domestic crude oil production, certainly all of the shifting to other energy sources may be stopped, not necessarily reversed, but further development would be stopped, so the OPEC cartel price becomes institutionalized to some extent, and this is the problem, but I think OPEC will not be again what it was in the 1970's. The great OPEC period is over. It may be able to maintain a price level, though, but the time when OPEC would get to sit down and tell the world the price has just gone up $8 a barrel and everybody says yes, sir and pays $8 a barrel more, that time is finished.

OPEC can at best maintain the existing price structure in nominal dollars so one way or the other, the world oil price will decline over the next several years, and I don't think OPEC will ever again be in a position, unless you have a physical shortage in which other things start to happen, will ever again be in a position where it can exert the kind of power we were all fascinated by in the 1970's.

Senator **Melcher**. The U.S. production today is higher than it was 5 or 6 years ago. Bringing the Prudhoe Bay field into production was started 5 years ago, 4 years ago. It has gradually gone up to about 1.5 million barrels per day, but that is the only new field of any consequence within the United States, and so the added production probably has come from the higher prices. Stripper wells came back, as have secondary and tertiary recovery, heavy oil production has come on stream, and with the lower prices now stripper production is going to drop off. Heavy oil production will drop off, so we are probably not looking at an increase in domestic production. We are probably looking at a decrease in domestic production because of those two types of oil that are contributing to our supply today.

What I don't understand, I don't think this panel is saying anything about encouraging exploration. I only know of one thing that encourages exploration in a market system like we have in the United States, and that is the price.

Dr. LICHTBLAU. Yes.

Senator MELCHER. So, being realistic, you don't foresee any increase in domestic exploration and therefore probably a drop in domestic production during the next let's just take the near term, during the next year? Isn't that true?

Dr. LICHTBLAU. Speaking for myself, not necessarily; it depends on what happens. The price of oil today, domestic price, of $29 is a very attractive price. At that price exploration is profitable and incentive is there.

Senator MELCHER. I am talking about increasing it.

Dr. LICHTBLAU. You don't necessarily need an increase in the price.

Senator MELCHER. I am talking about increasing exploration. I am not talking about holding that at the same level.

Dr. LICHTBLAU. Well, I think exploration could increase if that price remains approximately in that range because costs of drilling have gone down substantially. The cost of completing a well is much lower today than it was in 1982 or 1981, so you have two declines—price decline which wasn't all that much, and a decline in the cost, so if the price of oil approximately stays where it is, then incentive for further exploration and perhaps even increase if exploration is there—we have seen what has happened offshore California which is another area besides the Prudhoe Bay and besides the others that you mentioned, so that at present prices I think we can see—if the price drops significantly, it is another question.

However, we also have to look at the windfall profit tax. A decline in the price initially for much of the oil will go against the windfall profits tax but not so much in exploration because the profits tax on new oil, as you know, is relatively low.

Mr. SCHULER. Senator Melcher, if I could concur in two points that you made then, one, it seems to me that the giant oilfields that we are going to be looking for in the United States are going to be in the Arctic or in 6,000 feet of water and they are going to be very expensive oil to produce, and that these efforts are not going to be spurred by the price levels, collapsing prices that will be envisaged, but I would say that you also pointed out that it is the financial incentive, the profit incentive, that drives the exploration activity, and I think that if we were to deregulate natural gas in this country and get rid of the hokey system that is in place at this time, we could significantly increase the exploration activity of the natural gas, in the development of natural gas, which is not all in the Arctic and below 6,000 feet. It is readily available in the lower 48, and that natural gas can back out oil imports just as surely as finding oil in this country can back out oil imports.

Dr. CONANT. I think I would agree with the inference behind your question. The likelihood of further exploration increases in this country with an anticipation of an, even a moderate decline in prices, might happen, and therefore one of those indicators of early warning that we have to look at very carefully.

Senator MELCHER. Well, the Welsh Basin exploration dropped off when the decline came of $36. and hasn't picked up so that the exploration is going to drop even further with the price below $30.

Then the Overthrust Belt exploration is not picking up and will not pick up under these circumstances. Now I think perhaps it is fair to say that perhaps oil was overpriced. Would you agree? Would you agree to that, Mr. Schuler?

Mr. SCHULER. It depends on relative to what, Senator Melcher? Relative to the cost of alternatives or relative to the cost of production?

Senator MELCHER. Relative to the supply and the demand.

Mr. SCHULER. It was artifically maintained by OPEC, yes.

Senator MELCHER. And now there is the readjustment, and the question is how much of a readjustment? We talked about, you seemed to indicate, Mr. Schuler, that you are sticking to about the $30 level as being reasonable in the long run, and admitting that you are sticking your neck out.

Mr. SCHULER. In fact I have stuck it out even further and said I didn't think the Saudis would reduce it below the $34 level, but the reason for that is the politics of the situation and it has nothing to do with whether I think it is a good idea or a bad one.

Senator MELCHER. It is somewhat disregarding supply and demand?

Mr. SCHULER. Very much so.

Senator MELCHER. I think perhaps your guesses are as good as anybody, but I don't think I concur in the guess. I think we are going to see more of a drop than what you have indicated, and I think the $25 barrier may be the true barrier. It may be lower than that.

I think the only thing that is going to break that barrier is that decrease in supply, and that is why I mentioned stripper and heavy oil, because obviously there will be less production in stripper and heavy oil in the United States. I can't speak for other countries except perhaps for Canada, and that will be the same there, so the decrease in supply is sufficient to break the $25 buffer, leveling off, the bottoming out figure. That is one thing. It could go beyond that.

Thank you very much.

The CHAIRMAN. Gentlemen, I thank you very much. We have covered a great deal of ground in this wide-ranging discussion today, and we have uncovered about as many uncertainties as we have certainties, but Mr. Schuler, I am particularly intrigued by the thrust of your paper which indicates that the market has less to do with the decisions in many instances than do the internal political forces upon specific governments.

Mr. SCHULER. That is very much my view, Senator McClure, and that is in fact an assessment of what has taken place over the last decade.

If one looks at the Saudi decisions with respect to price, none of the economic models will support the view that they are economically driven by supply and demand or revenue optimization or anything of that sort, and in fact they have been driven by political considerations, whether political in order to resist regional pressures or to obtain international support or to defuse domestic political developments that would be against stability. After all, the House of Saud rules on a rather fragile basis, and their concerns have to be the immediate concerns of survival, not the long-term demand for Saudi oil or what is going to happen in the year 2000.

The **Chairman**. Would any of you care to predict what is going to happen in the war between Iran and Iraq now that might affect the political stability of the Middle East?

Dr. **Lichtblau**. I think the conventional wisdom is that it will drive on for quite a while. Neither side is strong enough to win and neither side is willing to make peace, and therefore, particularly the Iraqi oil will not be available for some time, and if the war came to an end, it would not be available immediately even then because it takes a while to build up the installations unless Syria permitted all four of its companies to produce oil.

As far as Iran is concerned, it is already at the level where, closer level where it would be anyhow. Iran produces 3 million barrels a day. That is within half a million barrels of where they would be otherwise, so Iran production is back in the market. Iraqi production isn't now, but if and when it comes, Iraqi production, you will have another, could eventually have another 2 million barrels a day of OPEC oil on the market, and eventually it will come because the war will come to an end maybe in 1983 or 1984.

The **Chairman**. Mr. Schuler?

Mr. **Schuler**. Senator McClure, I would answer that this way. If you are the Saudi princes and you are looking at the current Iranian effort to break through into Iraq, it is quiet at the moment but somebody indicated earlier it is simply off the front pages, but the pressure continues—now supposing, supposing the Iranians succeed in breaking through and I don't mean marching to Baghdad, but putting enough pressure on the producers, the removal of Saddam Hussein as ruler of Iraq, I would think that the Saudis would find that a particularly impropitious time to fly in the face of Iran's wishes that the price of oil not be reduced because they would then have a regime in Baghdad that was at least to some extent attuned with the region in Tehran and find themselves isolated from everybody, but on the other hand, if Iran finds itself frustrated in its effort to break through and to get rid of Saddam Hussein, I think a man would be pretty foolish to take on the Ayatollah when he is cornered. If he is beginning to feel lack of confidence and so forth, I don't think that is the time that you take any sort of a step which he is bound to view as virtually an act of war against Iran because he could send those planes across the Gulf and it might not make sense for anybody, but we have seen too much of that going on already, so I think either way I don't think the Saudis are well advised to lower price when Iran doesn't want it.

The **Chairman**. Iran is one of the major factors in holding the price up in the Gulf region?

Mr. **Schuler**. Holding everybody's price up; they want everybody else's price up so they can reduce their own from a higher level and maintain exports.

The **Chairman**. I would judge from what you are saying that a clear-cut victory by either side in that war might produce more instability rather than less?

Mr. **Schuler**. I think that is entirely likely.

The **Chairman**. Do you agree with that, Dr. Lichtblau?

Dr. **Lichtblau**. Yes, I definitely do.

Dr. CONANT. I would agree with Henry Schuler.

The CHAIRMAN. One of the characteristics of that war has been the kind of tacit understanding or at least the actions on the part of governments on both sides that they don't make wholesale, all-out assaults against the oil installations of the other. Karg Island, it sits out there very exposed, and yet the Iraqis have not really sought to take Karg Island. They can do so, and if they did so it would have a major impact upon the financial capacity of the Iranian regime.

Why haven't they moved toward Karg Island?

Dr. CONANT. The possible reason is the Saudis don't want them to, and they have been providing Iraq with very substantial subsidies over the last couple of years, and the last thing in the world the Saudis would want would be the Gulf gone mad. If Karg Island were to go out, that could prompt Iranian attack not upon Iraqi facilities but upon the country which they have long accused of being the one that keeps Iraq in war, so I think it is a fascinating game that is being played, and it may well be the Saudi desire that Karg Island not be taken out.

Dr. LICHTBLAU. It is all speculation. Everything is speculation because we don't know.

The other speculation is from people who have been there, who have been fairly close to it, that the Iraqis have been incapable of destroying Karg Island. They have tried but the distance is too big. Their planes can't go that far or if they could their pilots aren't good enough, but they have been incapable of doing it but have wanted to do it.

Certainly if Karg Island were destroyed the whole OPEC supply situation would be quite different because of the big change in OPEC, Iran from 700,000 barrels a day, gone up to now 2.5 million barrels a day in the last 12 months, so I don't know what the reason is, but according to some observers who have been on the spot it was not a design but inability to effect the destruction of Karg Island.

The CHAIRMAN. Well, aside from that, I would state my own opinion that Karg Island is very exposed and one team of frogmen on a scow could disrupt the production very substantially. As a matter of fact, the singular attack by the Iranians upon the Iraqi shipping facilities at the head of the Gulf was in precisely that manner. It wasn't an all-out technologically oriented high altitude or low altitude supersonic jet attack. It was by men, by water, at which those people are very adept. They practiced that kind of approach for generations.

Dr. LICHTBLAU. It is entirely possible. This is something that is prearranged, but Iraqi exports have been almost cut out by Iran, and we would assume Iraqi would have liked to retaliate and they have bombed Karg Island a number of times. You would assume they have done it so carefully as to damage it slightly but not to destroy. I doubt whether they would do it, and yet we know there have been attacks on Karg Island many times and sometimes there has been enough damage for a few weeks of very much reduced tanker holdings and then it picked up again. It is a fairly big place and it has a number of loading areas. If you destroy one, that is not enough. You have to destroy more of them.

I am not sure really that this conspiracy exists, but I have heard it before. It is entirely possible. I wouldn't want to say it doesn't exist.

The CHAIRMAN. Mr. Schuler, would you care to comment?

Mr. SCHULER. Only in that I am more persuaded by the argument that Mel Conant makes in this regard because it seems to me while the Iraqi oil production has been reduced and they have not retaliated to the extent that they could, as Mr. Conant points out, they are enjoying the benefit of Saudi production because of revenues and particularly at the time that Saudi Arabia went from 8.5 to 10 million barrels a day. They essentially turned over the revenues of that extra million and a half barrels a day of production to the Iraqis, so I think that they are very likely in tacit agreement, and the Iranians remind the Arab Gulf producers of their vulnerability periodically by having a stray plane that accidently bombs on the Kuwaiti side of the Iraqi border and so they are well aware of their vulnerability.

The CHAIRMAN. Let me shift gears for a moment. We have had some discussion today with respect to the drawdown on world stocks.

Do you have an opinion as to how much that drawdown of inventory is, the quantity of it?

Dr. LICHTBLAU. I think world commercial stocks are down to about 3.6, 3.7 billion barrels which is if you take let's say 2 years ago it was 1.5 billion barrels higher, 5.3, 5.4 billion barrels, so there has been a substantial drawdown. On a percentage basis the drawdown has been far more than the decline in demand.

On the other hand, the stock level at the beginning of 1981 was exceptionally high so some of that drawdown was necessary to bring stocks in line with demand. It was out of line at that time. It probably is still outside the United States above the 90-day floor. I know in Japan it was recently, a few weeks ago, slightly over a 100 days and in some European countries it is also clearly the high nineties, so inventory reduction has not yet been completed outside the United States.

In the United States it has not gone down very much recently. In fact, it has remained sort of flat so that I think there is further inventory reduction ahead. It may last another 4, 5 months. It depends on the expectation of prices. If the expectation is that the price will come down further, as you said earlier, there is no question that inventories will be further reduced, and it is possible to do so. The inventories are there. They are above the floor that is required, the mandatory floor. If the Geneva meeting had been successful at the end of January, I think you would not see a further inventory reduction today.

The CHAIRMAN. Dr. Conant?

Dr. CONANT. Yes, I would agree with what John has said. I am totally puzzled by this as to what the rate of drawdown is today. The range of opinions seems to really go somewhere between two and four. There is substantial difference.

If in fact it is four, then that minimum level that I was speaking about earlier is going to approach rather quickly, but I have no way of knowing which it is.

The CHAIRMAN. Mr. Schuler?

Mr. SCHULER. I would just say in support of the view that both of my colleagues have expressed that it is no time to be reducing the rate of fill of the strategic petroleum reserve because our overall energy security is a function of our private reserve and our strategic publicly owned reserve, so we should take little comfort from building the public reserve if at the same time our private reserve is being depleted at a much more rapid rate than we are building it, and I suspect that that is the case.

The CHAIRMAN. It is argued by the administration that the more we commit ourselves to public reserves the less uncertainty there is in supply and therefore the more willing the private sector will be to reduce their reserve.

Is that a measurable phenomenon or do you agree with the assertion?

Dr. LICHTBLAU. It is not measurable and I would question the assertion.

The CHAIRMAN. Mr. Schuler?

Mr. SCHULER. I think that the expectation of what is going on, where the price of oil is going, drives it far more than any expectation that the Government will bail them out when the time comes.

Dr. CONANT. I agree with both of them.

The CHAIRMAN. It is argued by the administration that we should not be adopting any measures that would ameloriate the shortfalls in the event of an emergency in order to force greater reliance upon market forces, now as well as after the crisis.

I take it from your views each of you expressed here that you think that these precrisis steps by our Government are far less determinative of private sector activity than the administration believes?

Dr. LICHTBLAU. Yes.

The CHAIRMAN. Is that the uniform opinion?

Dr. LICHTBLAU. Yes.

The CHAIRMAN. There are a number of other questions that may be submitted for the record, submitted to this panel and to the previous witnesses in writing, and if they are submitted by the end of this day, the record will remain open for a period of 2 weeks, your responses in writing may be included in the record.

I want to thank each of you for your testimony today, and I want to observe that we have been here now for almost 4 hours and the young lady taking the transcript has had no break. I wish to commend her for her diligence, too. Thank you.

If there is nothing further to come before the committee, the committee is adjourned.

[Whereupon, at 1:52 p.m., the hearing was adjourned.]

APPENDIX

RESPONSES TO ADDITIONAL COMMITTEE QUESTIONS

JAMES A. MC CLURE, IDAHO, CHAIRMAN

MARK O. HATFIELD, OREG.
LOWELL P. WEICKER, JR., CONN.
PETE V. DOMENICI, N. MEX.
MALCOLM WALLOP, WYO.
JOHN W. WARNER, VA.
FRANK H. MURKOWSKI, ALASKA
DON NICKLES, OKLA.
CHIC HECHT, NEV.
JOHN H. CHAFEE, R.I.
JOHN HEINZ, PA.

J. BENNETT JOHNSTON, LA.
HENRY M. JACKSON, WASH.
DALE BUMPERS, ARK.
WENDELL H. FORD, KY.
HOWARD M. METZENBAUM, OHIO
SPARK M. MATSUNAGA, HAWAII
JOHN MELCHER, MONT.
PAUL E. TSONGAS, MASS.
BILL BRADLEY, N.J.

MICHAEL D. HATHAWAY, STAFF DIRECTOR
CHARLES A. TRABANDT, CHIEF COUNSEL
D. MICHAEL HARVEY, CHIEF COUNSEL FOR THE MINORITY

United States Senate
COMMITTEE ON
ENERGY AND NATURAL RESOURCES
WASHINGTON, D.C. 20510

March 17, 1983

Mr. George Bradley, Jr.
Principal Deputy Assistant Secretary
for International Affairs
Department of Energy
Forrestal Building
Room 7C016
Washington, D.C. 20585

Dear Mr. Bradley:

The attached questions from various members are in follow-up to your appearance at the Committee's February 18 and 21 hearing on the world petroleum situation. Please provide your responses to these questions by April 18, 1983.

Sincerely,

James A. McClure

James A. McClure
Chairman

JAM/dar
Enclosure

1. Please provide the Committee with an assessment, by sector and by fuel type, of the amount of the decline in oil consumption since January 1981 which is attributable to temporary conservation, the amount attributable to permanent conservation, and the amount attributable to fuel switching.

2. Please provide the Committee with an assessment of the effect of the warmer than normal weather during the winter of 1982-83 on energy consumption by sector, and on primary oil stocks.

Department of Energy
Washington, D.C. 20585

April 15, 1983

Mr. Al Astrin
Committee on Energy and
  Natural Resources
United States Senate
Washington, D.C. 20510

Dear Mr. Astrin:

On March 4 we sent you the edited transcript with inserts of George Bradley's and Albert Linden's testimonies before the Senate Energy and Natural Resources Committee concerning the world petroleum outlook hearing held February 21, 1983.

Following the hearing, Chairman James A. McClure submitted additional questions to George Bradley, Jr. Enclosed are the answers to those questions.

If you have any questions, please call Ingrid Nelson or Tom Pretorius of my staff on 252-4277. They will be happy to assist you.

Sincerely,

for Thomas W. Pretorius

Robert G. Rabben
Assistant General Counsel
for Legislation

Enclosure

Attachment A

Question: Please provide the committee with an assessment, by sector and by fuel type, of the amount of the decline in oil consumption since January 1981 which is attributable to temporary conservation, the amount attributable to permanent conservation, and the amount attributable to fuel switching.

Answer: Because of the sometimes wide variation in data for any given month, we have analyzed this question in terms of the first quarter of 1981 compared to the fourth quarter of 1982. Also, the analysis concentrates on total petroleum demand in all sectors. A sectoral analysis would require considerably more specific information on the response of sectoral demand to sectoral prices and economic activity than is now available. In general, we believe that the sectors behave similarly enough with respect to these factors that sectoral analysis is not necessary for purposes of this assessment.

Petroleum demand during the first quarter of 1981 was 17.11 million barrels per day, compared to 15.12 million barrels per day during the fourth quarter of 1982, a decline of 1.99 million barrels per day. Of this decline, we estimate that the net effects of falling prices, reduced economic activity, and fewer heating degree-days account for approximately half of the decline. Of the remaining half, we do not have the information necessary to quantify the shares due to conservation, fuel switching, and the inherent error associated with our analytical methodology. However, fuel switching (discussed below) appears to have had a minor impact on the decline in oil consumption so far.

Investments which consumers and industry have made in insulation, more efficient furnaces, and more efficient automobiles over the past several years will have permanent impact on future consumption. Temporary conservation activities include reduced thermostat settings and less driving by motorists. Both kinds of conservation have contributed to the decline in petroleum demand over this period.

Finally, fuel switching appears not to have had a major impact on oil consumption. While petroleum consumption declined 12 percent from early 1981 to late 1982, total energy consumption declined almost 13 percent, with roughly similar decreases in coal and natural gas consumption. While there may be gradual trends away from oil in certain sectors, such as electric utilities, to date fuel switching does not appear to have had a significant impact on oil consumption.

Attachment B

Question: Please provide the Committee with an assessment of the effect of the warmer-than-normal weather during the winter of 1982-1983 on energy consumption by sector, and on primary oil stocks.

Answer: For the reasons discussed in Attachment A, this analysis concentrates on total petroleum demand in all sectors, rather than on sector-specific analysis. However, distillate and residual fuel oils, the most weather-sensitive of the petroleum products, are discussed separately.

In summary, from October 1982 through March 1983, the winter for the Nation as a whole has been 9.8 percent warmer than normal, and 14.1 percent warmer than last winter. As a partial consequence, total petroleum demand has averaged 770,000 barrels per day lower than last winter, or about a 4.9-percent decline. Of this decline, we estimate approximately 2.7 percent, or over half, is due to the warmer weather. Had heating degree days been at normal levels during this period, we estimate that petroleum consumption would have been 1.9 percent higher than actual, which would still have represented a 3.0 percent decline from last winter, which was 5.0 percent colder-than-normal.

Distillate and residual fuel oils have both shown substantial declines in consumption from last winter. Distillate fuel, over half of which is used for space heating during the winter months, declined 11.1 percent this winter compared to last. Of the decrease, we estimate approximately 6.5 percent, or three-fifths of the difference, is a result of the warmer winter. Residual fuel oil--about a third of which is used for electricity generation during the heating season--declined 24.3 percent from last winter. The weather-related decline is estimated to have been 10.7 percent, or just under half of the total decrease.

In terms of stocks, it is not possible to precisely quantify the impact of the relatively warm weather on stock levels. Any additional supply which would have been necessary this winter would have included a combination of higher production and imports, as well as stock withdrawals. Given the current (low) level of petroleum stocks, and the level that existed at the beginning of the winter, if the heating season had been colder, additional supplies would probably have been met with increased imports.

CSIS
Center for Strategic & International Studies
Georgetown University / 1800 K Street Northwest / Washington DC 20006 / Telephone 202/887-0200
TWX 7108229583 / Cable Address CENSTRAT

March 18, 1983

The Honorable James McClure
SD361 Dirksen Senate Office Building
Washington, DC 20510

Dear Senator McClure:

I am pleased to enclose a set of responses to questions which were sent to me following your February 21 hearings on "World Petroleum Outlook." It is my understanding that they are to be included in the formal record of the hearings.

Thank you for extending the invitation to testify and for your courtesy and interest in our remarks. It would be a privilege to do so again or to extend such other help as the Dewey Bartlett Energy Program might provide.

Sincerely,

G. Henry M. Schuler

G. Henry M. Schuler
Director
Energy Programs

GHMS/cad

cc: Howard Useem

QUESTIONS FOR MR. HENRY M. SCHULER, DIRECTOR OF ENERGY PROJECTS
FOR THE CENTER FOR STRATEGIC AND INTERNATIONAL STUDIES
PERTAINING TO THE HEARING ON "WORLD PETROLEUM OUTLOOK"
FEBRUARY 21, 1983

Q1. Mr. Schuler, in your written testimony you conveyed your view of the nation's continuing vulnerability to international oil disruptions and price escalations. You also alluded to domestic alternatives that you feel the U. S. possesses to alleviate this oil vulnerability. What are the most attractive options, in you opinion, to our current dependence on foreign oil imports?

Q2. Your testimony also refers specifically to this country's natural gas policies. Do you believe the current law is not encouraging expansion of supply and use of natural gas? What about the current natural gas surplus?

Q3. Would you please expand on the comment you made in response to a question from Senator Melcher to the effect that gas deregulation would lead to backing out more foreign oil?

Q4. What price would consumers pay for any reduced vulnerability to oil supply disruption brought about by natural gas decontrol compared with present law?

Q1. Mr. Schuler, in your written testimony you have conveyed your view of the Nation's continuing vulnerability to international oil disruptions and price escalations. You have also alluded to domestic alternatives that you feel the US possesses to alleviate this oil vulnerability. What are the most attractive options, in your opinion, to our current dependence on foreign oil imports?

A1. Among the nations of the Free World, the United States is uniquely fortunate in having a range of alternatives to imported oil, but, because most of those alternatives suffer from one or more constraints, the most realistic and attractive choice is, in my opinion, the expanded production and utilization of natural gas. Without going into detail, I think we all recognize that:

- o Utilization of natural gas does not depend upon the technological break-throughs which are almost certain to delay the contribution of solar electricity and nuclear fusion until the next century;
- o Natural gas does not impose the mining, transportation, air pollution and waste disposal problems which prompt environmentalists to limit coal expansion;
- o Use of Natural Gas avoids the emotional public outcry about the risks of low level radiation, catastrophic accident and weapons diversion which has imposed a halt on nuclear expansion and new technology;
- o Natural gas can compete with oil imports without the government supports which are required to develop shale

oil at a time when there is concern about budget deficits;

o And its potential can be tapped in places other than the Arctic and deep offshore waters where the search for the remaining giant oil fields is impeded by environmental and cost concerns.

Thus, on every count, U.S. natural gas offers the most acceptable substitute for foreign oil which last year still met one-third of our total oil demand at a cost of $60 billion in direct payments alone.

Q2. Your testimony also refers specifically to this country's natural gas policies. Do you believe the current law is not encouraging expansion of supply and use of natural gas? What about the current natural gas surplus?

A2. In my opinion, the Natural Gas Policy Act (NGPA) has created unnecessary and unacceptable cost barriers to both the expanded use and the expanded supply of natural gas. We should not be surprised that greater gas utilization has not been encouraged, for Congress expressly intended that NGPA and its companion legislation, the Fuel Use Act, should restrict boiler fuel use by utilities and industries because of the Carter Administration's contention that the United States was "running out of natural gas". Although that premise has since been discredited, the threat of legislative intervention through outright prohibition and the misnamed concept of "incremental pricing" has worked all too well in discouraging the construction of new gas boiler capacity and in prompting existing dual-fired capacity to switch to residual fuel oil. While policy makers fully intended that industrial users should bear the burden of higher costs and their inaccurate forecasts of shortage, they failed to envisage that their reliance on such federal controls would work to the detriment of the residential users whom they were trying to protect. In fact, the delivered cost of gas to residential users has escalated dramatically because those home owners have had to pick up a larger share of the fixed transmission and distribution costs when industrial users switched to alternative fuels.

On the other side of the equation, the NGPA has also failed to produce a cost-efficient or price-competitive expansion of gas supply. As intended, it has skewed drilling activity toward the so-called "deep gas" from below 15,000 feet,but a great many of those exploration successes have proven to be commercial failures. Although gas drilling will necessarily progress toward deeper and more elusive prospects as the more shallow and easily located fields are depleted, Congress was mistaken in its belief that it could accelerate that progression without hurting producers, pipelines and consumers alike. Operating 3 to 5 miles below the earth's surface under pressures and temperatures not previously encountered has strained technology and incurred costs which render much of that "deep gas" uncompetitive in today's market. Producers are hurt when their gas is too expensive to market and their bankers call the loans for very costly wells. Pipelines suffer when they have been forced by the shortages of just a few years ago to enter into "take-or-pay" contracts for the expensive gas which they no longer need. And, ultimately, consumers must bear not only the cost of higher prices for deep gas now under production but also the eventual cost of shortage occasioned by a lack of exploration activity due to the collision between legislative and market forces.

This is not to say that all or even most of the rise in residential prices is due to "deep gas" costs. The subsidization of Canadian and Mexican imports at $4.94 per mef, let alone Algerian LNG at upwards of $7 per mef, also plays a part. So do the contractual provisions which were responsive to the NGPA but serve perversely to turn the regulatory ceilings into floors. And, of course, the previously cited increases in transmission and distribution costs have played a very major role. Still, we should recognize that the NGPA's attempt to substitute legislative direction for competitive exploration has not produced an expansion of market priced gas.

But consumer costs must be measured in terms of future shortage as well as current prices. Unfortunately, the "surplus", often called a "gas bubble", to which you refer is not the result of long term expansion of supply but rather of a short term increase in deliverability resulting from economic recession and a legislative "quick fix". As noted, NGPA's provision of higher regulated prices for a number of artificially defined categories of gas and of deregulated prices for "deep gas" certainly produced more drilling activity and some expanded supply. However, a major contributor to the "gas bubble" has been the extension of federal regulation to the previously unregulated intrastate gas markets. In effect, those states which were suffering from shortages created by federal regulation tapped into the excess supplies which had been built up in other states which enjoyed a free market. Aside from the obvious inequities in this power play, it is clear that it can only be a one time "quick fix". Such steps serve merely to hide the real problem of an ever-declining reserve to production ratio which can only be overcome by permitting the market place to encourage and direct explorers to the most price competitive prospects.

Q3.**Would you please expand on the comment you made in response to a question from Senator Melcher to the effect that gas deregulation would lead to backing out more foreign oil?**

A3. Although New Zealand and Italy are making massive investments to convert their domestic natural gas reserves into motor fuel, gas is only competitive as a transportation fuel when the hidden costs of oil imports are "internalized" -- a strategic decision which the US is unlikely to make at this time. Therefore, the potential for domestic gas to "back out" imported oil arises in the stationery burner market provided by homes, factories and power plants. Since gas clearly outstrips oil in terms of convenience of handling and cleaness of burning, oil can only compete if it offers greater stability of price and security of supply. In estimating oil's ability to compete on those grounds, we must not allow a transient international "oil glut" to divert us from the obvious conclusion that we can place a great deal more reliance upon market-priced domestic gas than upon cartel-priced foreign oil. Clearly we cannot substitute gas for all oil; however, we must recognize that every reduction in our imports reduces demand pressures on international oil prices, enhances our economy and improves our ability to negotiate for our remaining import requirements.

Some contend that these arguments lose their force because the competition is from residual fuel oil which comes from the Caribbean rather than from the Middle East; however, this contention does not stand up to scrutiny. Firstly, it is incorrect to assume that all residual fuel from Caribbean refineries is processed from Venezuelan or other Western Hempispheric crude oil. In fact, those Caribbean refineries process a significant volume of Eastern Hemispheric crude, including that from Iran and Libya, with fuel oil and resid from Libyan crude being especially vuluable in the US because of its low sulfur content. Secondly, and perhaps more importantly, we should not assume that the bottom end of a barrel of crude oil can only yield resid suitable for burning under industrial boilers. Several years ago, when the American Gas Association still supported deregulation, it did a study which showed that, and I quote:

> "Heavy oil upgrading technology is available to completely eliminate production of residual fuel oil..."

The AGA study went on to show how refineries could be upgraded to convert all resid into gasoline and diesel fuel, thereby leaving the boiler market to natural gas and avoiding the importation of additional oil to make light products. In short, if Western Hemispheric crude is really more secure -- sometimes a doubtful proposition -- we should use it to meet our light product requirements instead of using to back-out domestic natural gas.

Q4. **What price would consumers pay for any reduced vulnerability to oil supply disruption brought about by natural gas decontrol compared with present law?**

A4. As I understand the question, it has two components: firstly, how will deregulated gas prices compare to those under NGPA; and, secondly, how will deregulated gas prices compare to world oil prices? In responding, let me make clear at the outset that I can offer you no new econometric model, but that doesn't bother me, for I look at the wide range of contending projections with a great deal of skepticism. In fact, I am fully convinced that 30 years of massive federal intervention and distortion of natural gas markets have made it impossible for anyone with even the most sophisticated computer to forecast market clearing prices with any degree of accuracy. Nonetheless, I am convinced that natural gas prices will clear the deregulated market place at a price lower than that which will prevail under the NGPA, provided that we move promptly. It seems to me that the coincidence of an "oil glut" and a "gas bubble" provides a unique window to unleash market forces. Unfortunately, that "window" is as narrow as it is unique so we must move immediately if we are to uncouple US gas prices from world oil prices.

My skepticism about anyone's ability to forecast US natural gas prices is only exceeded by my conviction that no one should pretend to forecast world oil prices which have been determined by politics for over a decade. Therefore, I will not attempt to do anything more than offer a reminder that US oil imports -- about $60 billion in 1982 -- is only a part -- perhaps half -- of the true economic and political cost of our continuing reliance upon imports to meet one-third of our total oil requirements. Many of those other costs such as foreign policy concessions, alliance strains and planning uncertainty are impossible to quantify, but we must note that the Department of Defense would like to spend $40 billion for the Rapid Deployment Joint Task Force and an additional $38 billion for two Carrier Task Forces for the Northwest Indian Ocean. And, those are only the procurement costs to which we must, of course, add enormous manpower, fuel and operating expenditures. Obviously some Senators would like to divert this $78 to social programs; others would use it to close the window of strategic missile vulnerability; while still others would prefer to balance the budget. I don't propose to choose between those options, but I urge you to judge the scare figures that you will hear on US gas deregulation costs against the $78 billion which the Pentagon must spend simply to procure the equipment to project military power into the oil producing region.